PB86-103173

Control of Industrial VOC (Volatile Organic Compound) Emissions by Catalytic Incineration. Volume 7. Catalytic Incinerator Performance at Industrial Site C-5

Radian Corp., Durham, NC

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

Jul 84

U.S. Department of Commerce
National Technical Information Service
NTIS

PB86-103173

EPA-600/2-84-118g
July 1984

CONTROL OF INDUSTRIAL VOC EMISSIONS BY CATALYTIC INCINERATION
Volume 7. Catalytic Incinerator Performance at Industrial Site C-5

by

C. J. Thielen
M. A. Palazzolo
Radian Corporation
Progress Center
3200 E. Chapel Hill Rd./Nelson Hwy.
Research Triangle Park, North Carolina 27709

EPA Contract 68-02-3171, Tasks 39 and 50

EPA Project Officer: P. Jeff Chappell
Industrial Environmental Research Laboratory
Office of Environmental Engineering and Technology
Research Triangle Park, North Carolina 27711

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/2-84-118g		PB86 103173

4. TITLE AND SUBTITLE	5. REPORT DATE
Control of Industrial VOC Emissions by Catalytic Incineration; Volume 7. Catalytic Incinerator Performance at Industrial Site C-5	July 1984
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
C. J. Thielen and Michael A. Palazzolo	203-001-50-33
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Radian Corporation 3024 Pickett Road Durham, North Carolina 27705	11. CONTRACT/GRANT NO. 68-02-3171, Tasks 39 and 50
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711	Final; 5/82 - 8/83 14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is P. J. Chappell, Mail Drop 63, 919/541-3738.

16. ABSTRACT The report is part of a two-phase EPA effort to assess the performance, suitability, and costs of various technologies to control emissions of volatile organic compounds (VOCs). In Phase 1, information was assembled from the literature on the use and cost of using catalytic incineration for VOC control. Results included: (1) a review of current and developing catalytic incineration technology, (2) an assessment of the overall performance of catalytic incinerators, (3) a review of applications where catalytic incinerators are used, (4) a comparative analysis of catalytic incineration with other competing VOC controls, (5) an examination of available methods for emission testing catalytic incinerators, and (6) an assessment of the need for additional performance test data. Phase 2 was a test program designed to increase the catalytic incinerator performance data base. It resulted in reports documenting the performance of eight catalytic incinerators at six industrial sites. The incinerators were used to control VOC emissions from solvent evaporation processes at can coating, coil coating, magnet wire, and graphic arts printing plants. Performance was measured at several process conditions at each site. Incinerator performance was characterized in terms of destruction efficiency, outlet solvent concentration, and energy usage. Design and operating data were collected.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution Incinerators Catalysis Organic Compounds Volatility Solvents Evaporation Magnet Wire Graphic Arts Printing Equipment	Pollution Control Stationary Sources Catalytic Incineration Volatile Organic Compounds Solvent Evaporation Can Coating	13B 11F, 20C 14E 07D 07C 20M 11K

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release to Public	Unclassified	95
	20. SECURITY CLASS (This page)	22. PRICE
	Unclassified	

EPA Form 2220-1 (9-73)

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The emission of volatile organic compounds (VOCs) from industrial plants significantly increases ambient levels of photochemical oxidants, ozone, and smog. Control of industrial VOC emissions, therefore, can result in substantial environmental benefits. This study was part of a comprehensive effort by EPA/IERL-RTP to assess the performance, suitability and costs of various VOC control technologies. The objectives of the EPA program were two-fold:

(1) to provide an overview of how catalytic incineration is applied to control industrial VOC emissions and to assess the overall performance, applicability, and costs as compared to alternate VOC control technologies, and

(2) to gather actual performance data through a field testing program on existing operating industrial catalytic incinerators.

The task of meeting these objectives was accomplished in two phases. In the first phase, information was assembled from the literature on the use and cost of using catalytic incineration for VOC control. This phase of the study provides results in the following areas:

- A review of current and developing catalytic incineration technology,
- an assessment of the overall performance of catalytic incinerators,
- a review of applications where catalytic incinerators are used,
- a comparative analysis of catalytic incineration with other competing VOC controls,
- an examination of the available methods for emission testing catalytic incinerators, and
- an assessment of the need for additional performance test data.

The second phase was a testing program designed to increase the catalytic incinerator performance data base. The testing program was planned so that 8 catalytic incinerators at industrial sites would be tested.

The outputs from this phase of the program consisted of a series of reports documenting the performance of 8 catalytic incinerators at 6 industrial sites. All 8 incinerators were used to control VOC emissions from solvent evaporation processes. Incinerators at can coating, coil coating, magnet wire, and graphic arts printing plants were tested. The performance measurements were made at several process conditions at each of the sites visited. Incinerator performance was characterized in terms of destruction efficiency, outlet solvent concentration, and energy usage. Incinerator design and operating data, such as operating temperature, solvent type, catalyst volume and age, were collected to document the operating conditions during the tests.

TABLE OF CONTENTS

		Page
1.0	Introduction	1
2.0	Summary	3
3.0	Process Description	7
	3.1 Wire Coating Process	7
	3.2 Catalytic Incineration Process	10
	3.3 Catalyst Maintenance	11
4.0	Sampling and Analytical Procedures	15
	4.1 Sampling Procedures	15
	4.1.1 Sample Acquisition for Volatile Organic Compounds and Carbon Dioxide	15
	4.1.2 Acquisition of Samples for GC/MS Analysis	17
	4.1.3 Moisture Determination	17
	4.1.4 Volumetric Gas Flowrate Determination	19
	4.1.5 Process Data	19
	4.2 Analytical Procedures	21
	4.2.1 Determination of VOC Concentrations	21
	4.2.2 Determination of Fixed Gases (Molecular Weight)	27
	4.2.3 Determination of Moisture Content	27
5.0	Results of Testing and Analysis	31
	5.1 Plant Operating Parameters	31
	5.2 VOC Sampling Results	35
	5.2.1 Summary of Method 25A Results	35
	5.2.2 Effect of Major Operating Parameters on Performance	37
	5.2.3 Results of Methane and Carbon Monoxide Analyses	43
	5.2.4 Results of Method 18 Analyses	46
Appendix A -	VOC Sampling Data	53
Appendix B -	Stack Gas Moisture Content, Volumetric Flowrate and Molecular Weight Determination	77
Appendix C -	Results of Gas Chromatographic Analysis	79
Appendix D -	Gas Chromatography/Mass Spectrometry (GC/MS) Results	83
Appendix E -	Example Calculation of Destruction Efficiency	86

LIST OF FIGURES

		Page
3-1	Schematic of coating process and incinerator at Plant C-5.....	8
3-2	Wire coating die.....	9
4-1	Positive pressure gas sampling system.....	18
4-2	EPA Method 4 moisture train.....	20
5-1	Destruction efficiencies of THC and NMHC.....	42

LIST OF TABLES

		Page
2-1	Summarized VOC Sampling Results	4
4-1	Sampling Procedures Matrix	16
4-2	Additional Incinerator Process Parameters for Performance Evaluation	22
4-3	Analytical Procedures Matrix	23
4-4	GC-MS Conditions for Analysis	28
5-1	Summary of Incinerator Operating Parameters - Plant C-5	32
5-2	Estimated Fuel Gas Energy Usage for Monitoring at Different Temperatures	34
5-3	Results of Method 25A Analyses for Plant C-5	36
5-4	Effect of Catalyst Age and Catalyst Outlet Temperature on Efficiency at Plant C-5	39
5-5	Inlet Concentration Versus Destruction Efficiency	41
5-6	Temperature Rise Across Catalyst Bed Versus Mass of Solvent Destroyed - Plant C-5	44
5-7	Results of Byron CO and CH_4 Analyses for Plant C-5	45
5-8	Results of Hydrocarbon Speciation of Inlet and Outlet Streams from Plant C-5	47
5-9	Destruction Efficiencies by Component - Plant C-5	49
5-10	Comparison of Method 25A and Method 18 THC Destruction Efficiencies	51
B-1	Summary of EPA Method 2 Test Results - Plant C-5	78
B-2	Summary of EPA Method 4 Test Results - Plant C-5	78
C-1	Results of Gas Chromatographic Analyses of Inlet Samples at Plant C-5	80

LIST OF TABLES (Continued)

		Page
C-2	Results of Gas Chromatographic Analyses of Outlet Samples at Plant C-5	81
D-1	Results of GC/MS Analyses of Extracts of Water from First Impinger of the Moisture Train	84
D-2	Results of GC/MS Analysis of the Coating Resin - Base Coat	85

SECTION 1

INTRODUCTION

Radian Corporation is conducting a testing program for the EPA (Contract No. 68-02-3171, Work Assignment 50) to document the performance of catalytic incinerators applied to industrial processes for volatile organic compound (VOC) control. Performance data collected at each test site is being summarized in a series of test reports (Volumes 3-8). A final report (Volume 2) presents comparative results of data from all test sites. This report presents test results from the incinerator at Plant C-5, a magnet wire plant.

VOC emissions are of concern to the EPA because they may react photochemically in the atmosphere to form photochemical oxidants. National Ambient Air Quality Standards (NAAQS) for photochemical oxidants are routinely exceeded in many areas of the United States. The objective of the current program is to gather performance data on industrial catalytic incinerators. This data will allow the EPA and industry to assess the potential reduction in VOC emissions that can be expected from using catalytic incinerators on various industrial processes. For purposes of discussion, the term VOC is used throughout this report to mean any volatile organic compound in the gas stream sampled.

The approach taken to evaluate the performance of industrial catalytic incinerators consisted of (1) developing plant-specific test plans and test methods to characterize incinerator performance and (2) performing several days of comprehensive on-site testing for each incinerator. Testing focused on the simultaneous monitoring of inlet and outlet VOC concentrations and measurement of incinerator operating conditions.

Incinerator destruction efficiencies presented in this report were determined by measuring inlet and outlet VOC concentrations according to EPA Method 25A. The Method 25A results represent total hydrocarbon (THC) concentrations in the gas streams on a carbon (C_1) basis. These THC values were determined by comparing the flame ionization detector (FID) response of the multicomponent gas streams sampled to the FID response of propane standards. The THC values represent a single FID response to a mixture of solvents and not the sum of responses to individual solvents in the mixture. The THC concentrations presented in this report cannot be compared to the percentages of individual components in the gas streams.

This report is divided into 4 sections beyond the Introduction (Section 1.0). Section 2.0 provides a summary of the results of the test. Section 3.0 gives a detailed process description and Section 4.0 discusses the sampling and analytical methods used at the site. The results of testing and analysis are presented in Section 5.0.

SECTION 2

SUMMARY

The catalytic incinerator at Plant C-5, a magnet wire plant, was performance tested in February, 1983. Testing focused on characterizing the effects of operating parameters on destruction efficiency and on determining energy usage. Results of the testing are summarized in this section.

The incinerator at Plant C-5 destroys solvents exhausted from a drying and curing oven on a wire coating line. The coating line produces magnet wire by coating bare wire with an electrically insulating enamel. The coating resins used at Plant C-5 are dissolved in a solvent mixture of phenol and cresols.

The incinerator tested at Plant C-5 handles an inlet solvent laden air (SLA) flowrate of approximately 0.49 m^3/s at 232°C (1030 acfm at 450°F). The incinerator has catalyst beds containing catalyst coated metal ribbons and is typically operated at an outlet temperature of 482°C (900°F).

During the one-week test period, incinerator performance was characterized for a single wire product at four catalyst bed outlet temperatures, two inlet solvent concentrations and two catalyst ages. Inlet and outlet VOC concentrations were monitored with total hydrocarbon (THC) analyzers and a gas chromatograph (GC). The results of the VOC sampling are summarized in Table 2-1.

The results in Table 2-1 show that the VOC destruction efficiency varied over a relatively wide range for the conditions tested. Major factors affecting the efficiencies were operating temperature, catalyst age

TABLE 2-1. SUMMARIZED THC SAMPLING RESULTS[a]

Catalyst Age	Average Incinerator Inlet THC Concentrations (ppmv)[b]	Average Incinerator Outlet THC Concentrations (ppmv)[b]	Destruction Efficiencies (%)	Catalyst Bed Outlet Temperature °C (°F)
Old[c]	8908	2194	73.9	499 (930)
New	8645	1669	79.5	482 (900)
New	8299-8720	1591-1666	78.7-80.6	510 (950)
New	8862-9175	1374-1564	81.1-83.5	554 (1030)
New	9021	1529	82.0	577 (1070)
New	4638-5047[a]	1155-1526	65.1-75.7	454 (850)

[a]Data presented in this table are for normal process operating periods with the exception of the period for an inlet concentration between 4638 and 5047. During this period only half of the coating line was operating.

[b]ppmv = parts per million by volume as carbon, quanitated against propane standards.

[c]The first catalyst in the incinerator was of unknown age. This catalyst was replaced after the first day of testing.

and inlet THC concentrations. Destruction efficiency increased with increasing outlet temperature up to 554°C (1030°F). At a higher temperature, the efficiency apparently decreased because of a lower fuel combustion efficiency in the incinerator burner. The lower fuel combustion efficiency resulted in a relatively high concentration of methane in the incinerator outlet gas.

The natural gas energy requirements for the Plant C-5 incinerator were estimated to range from 2.1×10^8 to 3.6×10^8 J/hr (2.0×10^5 to 3.4×10^5 Btu/hr).

SECTION 3

PROCESS DESCRIPTION

Plant C-5 produces magnet wire by coating bare copper wire with an electrically insulating enamel (SIC 33577). The wire is coated with a thin coat of resins dissolved in phenol and cresols. The coated wire passes through a drying oven where the solvents evaporate and the resins cure. The exhaust from the oven is ducted to a catalytic incinerator for solvent destruction. The plant operates 24 hours per day, 7 days per week.

The wire coater and catalytic incinerator tested at Plant C-5 are described in this section. Operation of the wire coater is discussed in Section 3.1 and the design and operation of the incinerator are discussed in Section 3.2. Catalyst maintenance practices are described in Section 3.3.

3.1 WIRE COATING PROCESS

A schematic diagram of the coating process and the catalytic incinerator at Plant C-5 is shown in Figure 3-1. Annealed copper wire is unwound from spools and passed through a bath of resins dissolved in phenol and cresols. The coated wire is then drawn vertically through an orifice or coating die as shown in Figure 3-2. The die scrapes off excess coating, leaving a thin film of a desired thickness.

After the wire passes through the coating die, it enters an oven where the coating dries and cures. The wire is coated and dried repeatedly until a desired thickness of 4 to 12 layers is obtained. The finished wire is then rewound onto spools for shipment.

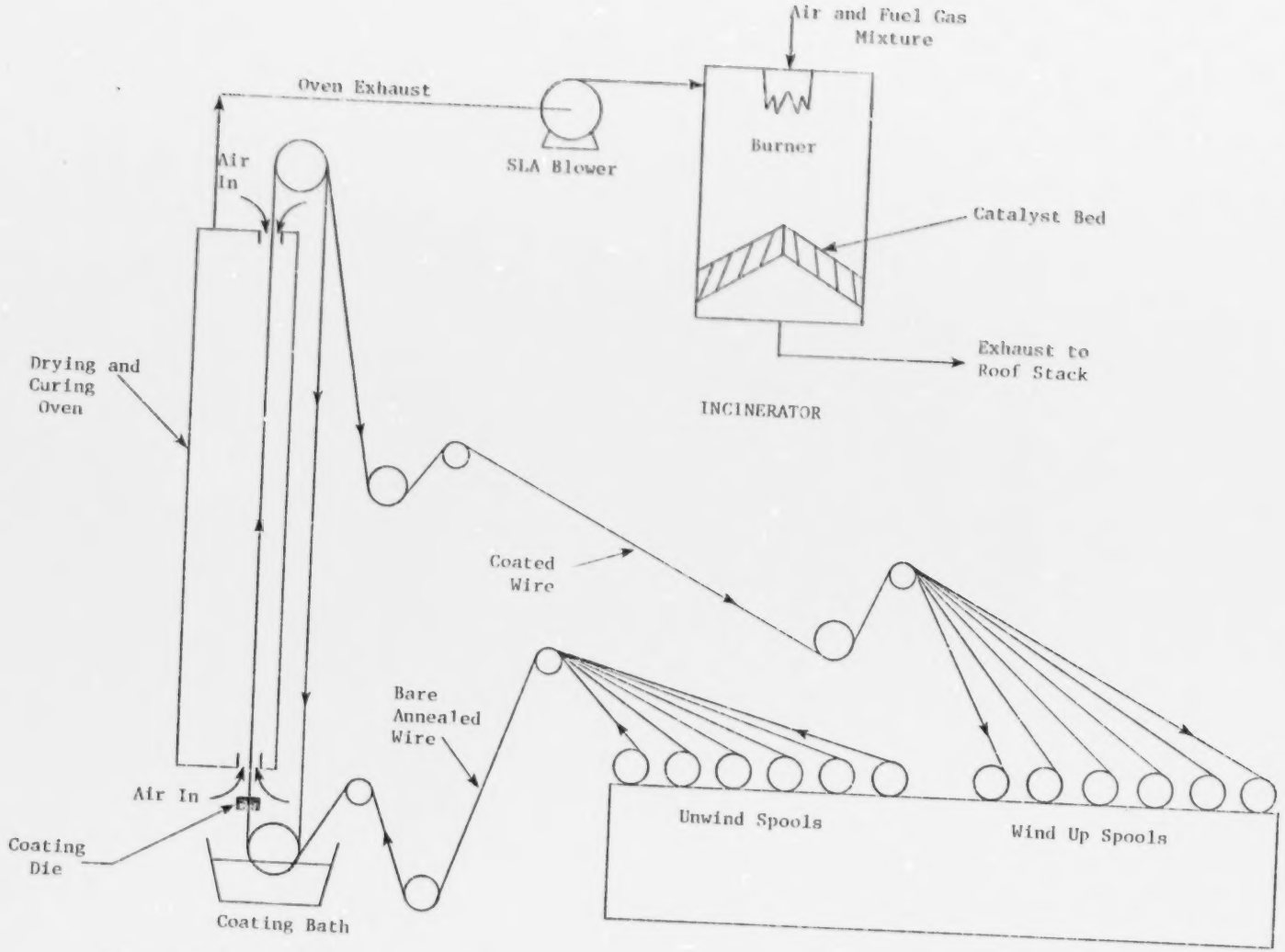

Figure 3-1. Schematic of coating process and incinerator at Plant C-5.

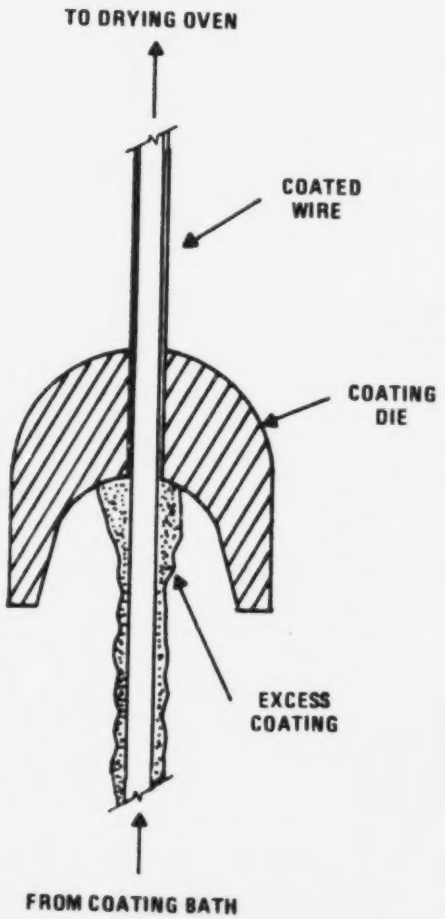

Figure 3-2. Wire coating die. (Reference 1).

Operation of the wire coater is continuous. The coater continues to operate during employee breaks and shift changes. Full spools of bare wire are spliced in at the end of each empty spool to avoid the need for process shutdown.

The wire coater tested at Plant C-5 produces 24 strands of a medium gauge magnet wire at the same time. The coater produced the same product throughout the test period. The coating contained from 20 to 40 percent solids and a solvent mixture consisting of phenols, cresols, and a small amount of xylenes. Based on plant data, the solvent usage rate during the testing was 4.5 kg/hr (10 lb/hr).

3.2 CATALYTIC INCINERATION PROCESS

As shown in Figure 3-1, solvent laden air (SLA) is drawn from the drying oven by a blower and passes into the burner zone of the incinerator. The gas is heated in the burner to approximately 399°C (750°F) by the combustion of a 9:1 air/fuel mixture. The hot gas then passes through the catalyst bed where the solvents are oxidized. The outlet gas from the incinerator, typically at 510°C (950°F), is exhausted to the atmosphere via a stack.

The air/fuel mixture used in the incinerator contains natural gas and sometimes propane. During the first 3 days of testing at Plant C-5, the fuel consisted of 6 percent propane and 94 percent natural gas.

The SLA gas flowrate at the incinerator inlet is approximately $0.49 Nm^3/s$ at 233°C (1030 acfm at 450°F). The inlet gas flowrate remains constant during normal operation. However, the inlet solvent mass flowrate varies with the type of coating, the number of wires, the wire diameter and the line speed.

The incinerator tested at Plant C-5 was originally designed and manufactured by OxiCatalyst Incorporated (circa 1965) and was later modified by the plant. The modification involved switching from a ceramic-based catalyst to a metal-based catalyst. Further, the catalyst bed configuration was changed to increase the catalyst volume. Originally, the catalyst bed was perpendicular to the gas flow and not angled in the manner shown in Figure 3-1.

The catalyst tested consists of catalyst coated metal ribbon enclosed in two modules, giving a total catalyst bed volume of 0.024 m^3 (0.83 ft^3). No data are available on the void fraction or the active surface area of the catalyst bed. Assuming a void fraction of 40 percent, the residence time of the SLA in the bed would be about 0.015 seconds.

The incinerator at Plant C-5 is instrumented so that operation of the incinerator is fully automatic after system start-up. The following instrumentation and controls are installed on the incinerator:

- a multipoint strip chart recorder indicating catalyst bed inlet and outlet temperatures and drying oven zone temperatures,
- a catalyst outlet temperature controller to maintain an outlet temperature set point of 510°C (950°F), and
- a high temperature limit switch to initiate process shutdown if the incinerator outlet temperature exceeds 649°C (1200°F).

3.3 CATALYST MAINTENANCE

Catalyst maintenance practices employed at Plant C-5 to maximize catalyst life and incinerator efficiency are discussed in this section. Catalyst maintenance at the plant is particularly important because of the types of coatings and solvents used in manufacturing magnet wire.

The typical catalyst life for incinerators on wire coaters at Plant C-5 ranges from 3 to 24 months, depending on the type of coating being used. For the coating and incinerator tested, the catalyst usually lasts between 6 and 18 months. Catalyst deactivation is suspected to be caused by small amounts of silicon in the wire coatings. Other possible causes include solvent or coating condensation on the catalyst during system start-up or shutdown.

The catalyst beds at the plant are thermally cleaned on a monthly basis and physically cleaned and inspected semi-annually. Thermal cleaning involves heating the catalyst bed by increasing the catalyst bed temperature to approximately 538 or 566°C (1000 or 1050°F) for 1 or 2 hours. Physical cleaning involves removing the catalyst from the incinerator and cleaning it with soap and water. The physical cleaning removes loose dirt or combustion products that may be on the surface of the catalyst. Following physical cleaning, the catalyst is visually inspected to determine if the catalyst can be reused or if it should be rejuvenated.

Catalyst rejuvenation is performed by the catalyst manufacturer. Rejuvenation involves stripping the old catalyst off the base metal and recoating the base metal with fresh catalyst. The performance of the rejuvenated catalyst should equal that of a new catalyst.

Aside from the semi-annual visual inspection, the need for catalyst replacement is primarily determined by monitoring the temperature rise across the catalyst bed. When a catalyst is observed to have a low temperature rise relative to when it was installed, the catalyst is thermally cleaned. If the temperature rise does not increase notably after thermal cleaning, the catalyst is then replaced with new or rejuvenated catalyst.

SECTION 3 REFERENCES

1. Johnson, W. L., and R. Quaney. "Control of Volatile Organic Emissions from Existing Stationary Sources - Volume IV: Surface Coating for Insulation of Magnet Wire". U. S. Environmental Protection Agency, EPA 450/2-77-033, December 1977.

SECTION 4

SAMPLING AND ANALYTICAL PROCEDURES

Testing procedures followed during the performance evaluation of the catalytic incinerator operated by Plant C-5 are presented in this section. Sampling procedures are discussed in Section 4.1 and analytical procedures are discussed in Section 4.2. Quality assurance/quality control procedures and results for Plant C-5 are discussed in the Quality Assurance Project Plan and Quality Assurance Report (Volume 9) for this program.

4.1 SAMPLING PROCEDURES

This section describes the sampling methodology Radian used to characterize the operation and determine the destruction efficiency of the Plant C-5 incinerator. EPA reference methods were typically used; however, some non-reference methods or modifications of reference methods were needed. The modifications are discussed in this section. A sampling procedure matrix is presented in Table 4-1.

4.1.1 Sample Acquisition for Volatile Organic Compounds and Carbon Dioxide

Both the incinerator inlet and outlet gas streams were continuously sampled throughout the test. A three-hole sampling rake was used to extract the gas sample from the main gas stream. As required by Method 25A specifications, the sampling rake had holes 3.2 mm (1/8 in) in diameter drilled in the tubing at a relative location of 16.7, 50 and 83.3 percent of the equivalent duct diameter. Sample gas passed through 1.8 m (6 ft) of heat-traced stainless steel line and a heated (205°C, 400°F) sampling pump before entering a heat-traced Teflon^{R} umbilical that carried it to a mobile laboratory. During transport through the umbilical from the duct to the

TABLE 4-1. SAMPLING PROCEDURES MATRIX

Parameter	Procedure
Volatile Organic Carbon (VOC) Content	EPA Method 25A
Sample for GC/MS Analysis	Water from the moisture train impingers
Moisture	EPA Method 4
Velocity/Volumetric Flow Rate	EPA Methods 1 and 2
Temperature	Thermocouple
Duct Pressure	Magnehelic® gauge or manometer
Other Process Data	Plant monitors or O&M records

laboratory, the sample gas was maintained at 138°C (280°F). Using this sampling system the residence time of the sample gas in the sample lines was approximately 20 seconds.

A manifold system inside the mobile laboratory was used to split the sample streams for analysis with two types of instruments, an organic species analyzer and a THC analyzer. A schematic of this sampling arrangement is shown in Figure 4-1.

4.1.2 Acquisition of Samples for GC/MS Analysis

Samples for GC/MS analysis were acquired from two sources. The first source of samples was the impinger water from the moisture train. As the hot outlet gas was drawn through the impingers, some of the gas contents dissolved in the water. This was evidenced by the light pink color of the coating resin in the water. The water from the first impinger of the moisture train was therefore transferred to a clean sample bottle and shipped to Radian's Austin laboratories for extraction and analysis. The second source of GC/MS samples was the coating resin used to coat the bare wire. Grab samples of these coatings were also collected in clean sample vials and shipped to Austin for analysis.

4.1.3 Moisture Determination

The moisture content of the incinerator exhaust stream was determined using the methodology prescribed in EPA Method 4. Based on this method, a measured volume of particulate-free gas is pulled through a chilled impinger train. The contents of the 4 impingers are:

- 250 ml water
- 250 ml water
- Dry
- Silica Gel

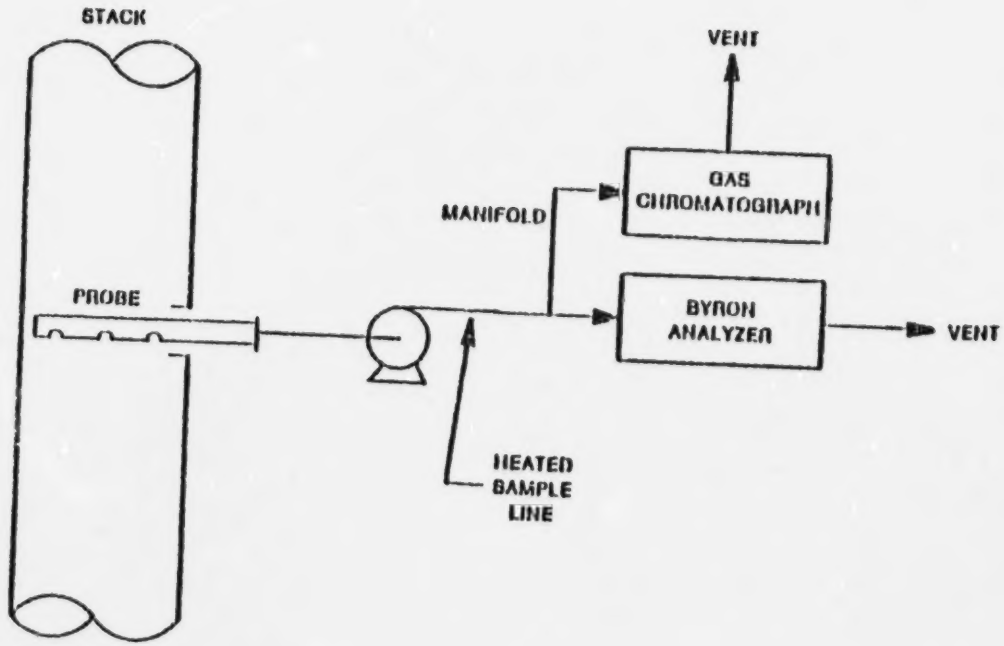

Figure 4-1. Positive pressure gas sampling system.

The quantity of water condensed in the impingers is determined gravimetrically and then related to the volume of gas sampled to determine the moisture content. Figure 4-2 graphically illustrates the sampling train which is used for moisture determination.

4.1.4 Volumetric Gas Flow Rate Determination

The volumetric gas flow rate of the incinerator outlet stream was measured using procedures described in EPA Method 2. As prescribed by this method, the volumetric gas flow rate was determined by measuring the average velocity of the flue gas. The average gas velocity was calculated from the average gas velocity pressure (ΔP), the average flue gas temperature, wet molecular weight, and the absolute pressure in the stack. Temperature and ΔP profiles were obtained by traversing the stack.

Temperature profile and ΔP data were collected at each of the sampling points using a K-type thermocouple and an S-type pitot tube. A gauge oil manometer was used to measure the pressure drop (ΔP) across the S-type pitot. The daily barometric pressure was obtained from a local weather station and corrected for elevation.

The volumetric gas flowrate of the incinerator inlet could not be measured according to EPA Method 2 because no acceptable sampling location was available. The inlet gas flowrate was calculated using the measured outlet gas flowrate and estimated combustion air and fuel gas flowrates. The estimating procedure is discussed further in Section 5.1.

4.1.5 Process Data

In addition to VOC concentrations, moisture contents and volumetric flow rates, several process parameters were determined or obtained at various points in the incinerator. These parameters included pressure drops across each stage of the system, intermediate temperatures, and combustion

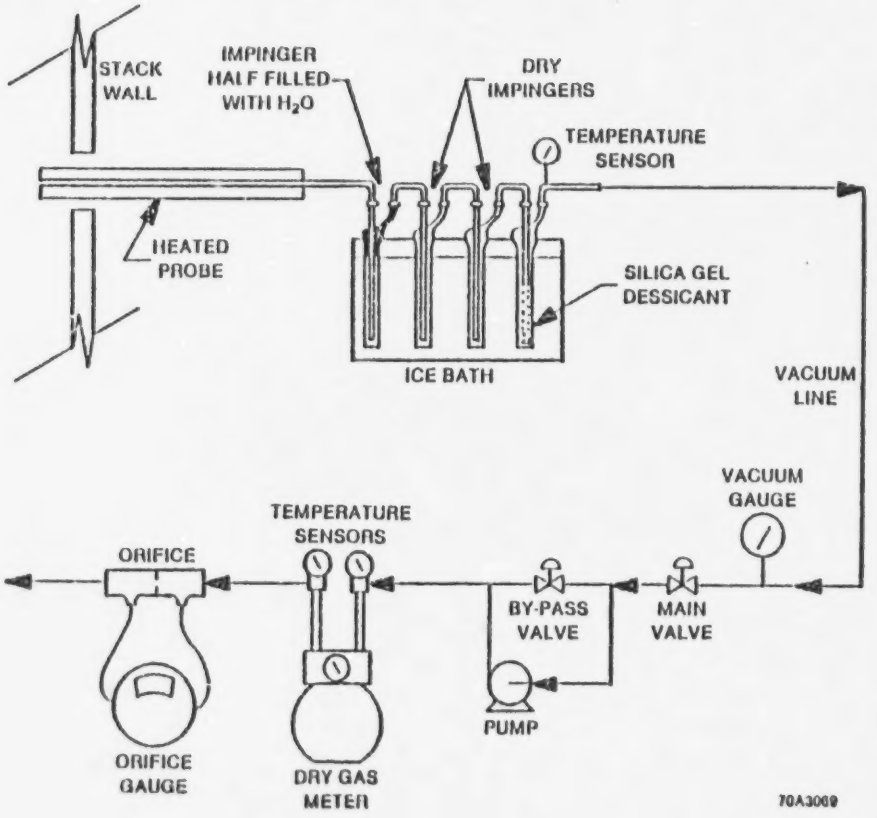

Figure 4-2. EPA Method 4 moisture train.

air and fuel parameters. These additional parameters and the methods which were used for their quantitation are presented in Table 4-2. In many instances, these data were obtained from the plant.

4.2 ANALYTICAL PROCEDURES

This section details the analytical methodology Radian used to characterize operational conditions and to measure the destruction efficiency of the Plant C-5 incinerator. EPA reference methods were used where applicable. Any non-reference method or modifications of reference methods are discussed in this section. An analytical methods matrix is presented in Table 4-3.

4.2.1 Determination of VOC Concentrations

On-site VOC determinations were accomplished using two methods, EPA Method 25A and the draft Method 18. The first method uses flame ionization detection (FID) to provide total hydrocarbon (THC) concentrations. Similarly, the second method also uses an FID for quantification; however, the various organic species in the gas sample are chromatographically separated prior to detection.

4.2.1.1 EPA Method 25A--

Method 25A specifies that THC determinations be performed using a continuous monitor equipped with an FID. Although an FID was used on this project, monitoring was performed on a semi-continuous basis using two instruments: a modified Tracor 560 gas chromatograph connected to the inlet sampling manifold and a Byron THC analyzer connected to the outlet sampling manifold.

A Tracor model 560 gas chromatograph (GC) was used to measure THC in the incinerator inlet stream. However, modifications were necessary in order to convert the GC to an automated THC analyzer. Modifications

TABLE 4-2. ADDITIONAL INCINERATOR PROCESS PARAMETERS FOR PERFORMANCE EVALUATION

Stream	Parameter	Test Method
Incinerator Auxiliary Fuel	Type	Plant Data
	Composition	Plant Data
	Heating Value	Plant Data
	Rate	Plant Data
Combustion Air	Rate	Plant Data
Exhaust Gas or Stack Incinerator	Velocity Profile	EPA Methods 1, 2, 3[a] and 4
	Temperature Profile	
Heat Recovery Data	Inlet/Outlet Temperatures	Thermocouple

[a]Molecular weight was determined using a Fyrite for O_2 and the Byron 401 for CO_2 on the outlet. Nitrogen was calculated by difference.

TABLE 4-3. ANALYTICAL PROCEDURES MATRIX

Parameter to be Measured	Method
VOC Concentration	EPA Method 25A Draft EPA Method 18 GC/MS Analysis
Fixed Gases (Molecular Weight)	Fyrite and Byron 401 Analyzer
Moisture	EPA Method 4
Velocity/Volumetric Flow Rate[a]	EPA Methods 1 and 2
Temperature[a]	Thermocouple
Pressure[a]	Magnehelic® Gauge or Manometer
Other Process Data[a]	Plant Monitors or O&M Records

[a]Discussed in detail in Sections 4.1.4 and 4.1.5.

included using a piece of 1/16" empty stainless steel tubing instead of a chromatographic column to direct inlet sample gas to the FID and an electronic timer to control an air-actuated injection valve. This timer was set to inject inlet gas samples at approximately 10-minute intervals.

Data from the GC was integrated and stored on a Hewlett-Packard 3380A integrator. Dates and times of monitoring periods were manually recorded at the beginning and end of each period. Integrated peak areas from the integrator were later entered into a computer to determine the THC concentrations for each injection.

A Byron 401 was used to measure THC, carbon monoxide (CO), carbon dioxide (CO_2) and methane (CH_4) in the incinerator outlet stream. The Byron 401 analyzer is a non-specific process gas chromatograph utilizing a flame ionization detector (FID) system to quantitatively determine selected carbon containing compounds. The instrument was operated mostly in the THC mode because the one-minute cycle time allowed measurement of relatively rapid concentration changes. The full scan mode was operated for brief periods to obtain measurements of CO, CO_2, and CH_4 in the outlet gas.

At the beginning of a THC cycle, internal contact closure occurs to allow the sample loop to equilibrate to atmospheric pressure. After 12 seconds, a sample inject valve actuates and gas in the sample loop is swept directly into the FID. The cycle repeats after one minute.

In the full scan mode, the cycle time is 12 minutes. The gas sample introduced into the 401 is ultimately separated into five groups of compounds:

- total hydrocarbons,
- C_3+ hydrocarbons,
- carbon monoxide (CO) and methane (CH_4),

- carbon dioxide (CO_2), and
- the C_2 hydrocarbon group.

In operation the full scan cycle proceeds by first stripping the C_3+ group out of the sample contained in the sample loop. This is done using a chromatographic column which retains C_3+ compounds while allowing the remainder to pass through to a separation column. Meanwhile, the separation column separates the balance of the sample into the remaining three groups. CO and CH_4 emerging from the separator are retained on a 5A molecular sieve storage column while the CO_2 and C_2 groups are eluted. CO and CH_4 are then resolved and follow the same path to the FID where they are measured separately as CH_4.

The electronics in the instrument provide fixed time peak detection windows, auto zeroing and peak integration capabilities. For six seconds after each peak window opens, the detector signal is monitored and auto zeroing occurs. During the remainder of each peak window, the detector signal is amplified and passed to a storage capacitor to accumulate the total charge from the detector. The amplified signal is continuously monitored with a strip chart recorder. At the end of the peak window, a signal representing the integrated area of the peak (the accumulated charge) is transferred to a capacitor. This charge is used as the input to a computer data acquisition system and remains there until completion of the peak window for the next cycle.

All data from the Byron instrument were automatically recorded, stored on disk, and reduced using an Apple^R II minicomputer. The computer also recorded the date and time of analysis, instrument, and sampling location. As a backup to the minicomputer data acquisition system, integrated areas of the peaks generated by each instrument were recorded using a strip chart recorder.

4.2.1.2 Method 18--

The draft Method 18 differs from Method 25A in that sample acquisition may be performed either by direct interface or by grab sampling. In addition, the organic species content in the stream is chromatographically separated prior to detection by FID.

The draft Method 18 provides for the individual quantitation of organic species by gas chromatography using a flame ionization detector (FID). These analyses were performed on the same sample gas used for Method 25A. Analyses were performed simultaneously with the Method 25A analyses whenever possible. The gas sample was introduced into a fixed volume sample loop on an oven-mounted, 10-port stainless steel valve. After the loop was flushed with at least a 100-fold volume of sample, the gas flow was stopped and the loop was allowed to come to atmospheric pressure. The valve was then switched to the inject position. The instrument and analytical conditions used were:

- Instrument: Hewlett-Packard Model 5730A
- Column: 20 ft. x 1/8" o.d. stainless steel; 10% OV-101 on 80/100 Supelcoport
- Carrier Gas: Nitrogen, 30 mL/min
- Temperature Program: Isothermal at 155°C
- Injection: 5 mL fixed volume loop
- Detector: 250°C

4.2.1.3 GC-MS Method--

GC/MS analysis was performed to determine organic species in water samples from the first impinger of the moisture train and in coating resin samples.

The water samples were prepared for analysis by extraction with methylene chloride under both basic and acidic conditions. The extracts

were combined and concentrated to 1 ml using a Kuderna-Danish apparatus and 3-ball Snyder column. An aliquot of this extract was injected into the GC/MS for analysis.

The resin coating was prepared for analysis by dissolving a small amount of the resin in methylene chloride. An aliquot of this dissolved resin was then analyzed by GC/MS. The instrument and analytical conditions for these analyses are summarized in Table 4-4.

4.2.2 Determination of Fixed Gases (Molecular Weight)

The molecular weight of the incinerator outlet stream was determined using a combination of two methods, a Fyrite^{R} apparatus and a Byron 401 analyzer. The oxygen content of the outlet stream was determined using an oxygen Fyrite^{R} apparatus. Gas sample for oxygen analysis was drawn directly from the outlet sampling port. The carbon dioxide content of the outlet stream was measured using the Byron 401 analyzer in the full scan mode. Gas sample for CO_2 analysis was drawn from the Method 25A sampling manifold. The nitrogen content of the outlet stream was determined by difference.

4.2.3 Determination of Moisture Content

The moisture content of the incinerator inlet and exhaust streams was determined using the methodology described in EPA Method 4. By this method, a measured volume of particulate-free gas is pulled through a chilled impinger train. The quantity of water condensed in the impingers is determined gravimetrically and then related to the volume of gas sampled to determine the moisture content.

TABLE 4-4. GC-MS CONDITIONS FOR ANALYSIS

GC-MS Conditions	
Instrument	Hewlett-Packard Model 5982
Ionization voltage	70 eV
Scan rate	1 scan/sec
Scan range	10-200 amu
Column	25 meter DB-5 Fused Silica wide bore thick film
Initial temperature	-50°C
Program rate	16°C/min
Final temperature	280°C
Interface	Open split coupled

SECTION 4 REFERENCES

1. EPA Proposed Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer," Proposed Revision to Appendix A 40 CFR, Federal Register, Volume 45, Number 194, December 17, 1980. pp. 83149-83151.

2. EPA Draft Method 18, "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography," Personal communication with Jeff Chappell, U.S. Environmental Protection Agency, IERL-RTP.

3. EPA Reference Method 3, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight," Appendix A to 40 CFR, Environmental Reporter, Bureau of National Affairs, Washington, D.C., December 5, 1980. pp. 33-36.

4. EPA Reference Method 4, "Determination of Moisture Content in Stack Gases," Appendix A to 40 CFR, Environmental Reporter, Bureau of National Affairs, Washington, D.C., December 5, 1980. pp. 36-41.

5. EPA Reference Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube), Appendix A to 40 CFR, Environmental Reporter, Bureau of National Affairs, Washington, D.C., December 5, 1980. pp. 25-33.

SECTION 5

RESULTS OF TESTING AND ANALYSIS

The catalytic incinerator at Plant C-5 was tested from February 15 through February 19, 1983. Data collected from this incinerator showed destruction efficiencies ranging from 65 to 83.5 percent. These efficiencies result from data collected at four temperatures, two inlet concentrations and two catalyst ages.

The results of the testing conducted at Plant C-5 are presented in this section. Operating parameters and VOC sampling results are discussed in Sections 5.1 and 5.2, respectively. Section 5.2 includes a discussion of several parametric analyses which were performed using Plant C-5 data.

5.1 PLANT OPERATING PARAMETERS

The operating conditions and parameters measured and/or recorded during the testing at Plant C-5 are summarized in Table 5-1. These data include gas temperatures, inlet solvent laden air (SLA) and outlet gas flowrates, outlet gas moisture content and energy usage.

The gas temperatures were continuously monitored and recorded using type K thermocouples and a multipoint strip chart recorder. Direct measurement of the inlet gas flowrate was not possible because an acceptable sampling location was not available. The flowrate was, therefore, estimated from the outlet gas, fuel gas and combustion air flowrates. The outlet gas flowrate was determined using EPA reference Method 2 and the moisture content was measured using EPA Method 4.

TABLE 5-1. SUMMARY OF INCINERATOR OPERATING PARAMETERS - PLANT C-5

Parameter	Average Value	Range
Catalyst inlet temperature	399°C (750°F)[a]	379-493°C (715-920°F)[b]
Catalyst outlet temperature	477°C (890°F)[a]	454-577°C (850-1070°F)[b]
Inlet SLA flowrate[d]	0.270 Nm^3/s (573 dscfm)	0.256-0.279 Nm^3/s (542-591 dscfm)
Inlet SLA temperature	233°C (451°F)	224-241°C (435-465°F)
Outlet gas flowrate[d]	0.287 Nm^3/s (608 dscfm)	0.273-0.296 Nm^3/s (579-628 dscfm)
Outlet gas temperature[d]	498°C (928°F)	457-557°C (854-1034°F)
Outlet gas moisture content[d]	5.01%	4.89-5.27%
Catalyst bed pressure drop	0.17 kPa (0.7"H_2O)	--
Estimated fuel energy usage[e]	2.4 x 10^8J/hr (2.3 x 10^5 Btu/hr)	2.1 x 10^8-3.6 x 10^8J/hr (2.0 x 10^5-3.4 x 10^5 Btu/hr)
Fuel gas usage[f]	6.3 m^3/hr (3.7 scfm)	--
Combustion air flowrate[g]	58 m^3/hr (33 scfm)	--
Fan energy requirements[h]	1.1 kW	--

[a]This "average" temperature is the normal plant operating temperature.

[b]This temperature was varied intentionally over this range to characterize incinerator performance.

[c]Based on stack gas flowrate measurements and estimated fuel gas and combustion air flowrates.

[d]For incinerator outlet stack venting to atmosphere. Volumetric flowrate and moisture data are summarized in Appendix B.

[e]Estimated from gas temperature rise across burner zone of incinerator and tabulated values for combustion gas enthalpies (Reference 1).

[f]Based on propane and natural gas heating values of 2385 and 1025 Btu/scf, respectively. A mixed fuel (6% propane in natural gas) was used during testing conducted between 18:00 on 2/15/83 and 10:00 on 2/18/83. 100% natural gas was used during all other testing periods.

[g]Based on plant data of 9:1 ratio of combustion air to fuel by volume.

[h]Measured by ammeter.

Fuel energy consumption was estimated from the change in enthalpy (ΔH) of the SLA as it passed through the incinerator burner. Enthalpies used in these calculations were obtained from tabulated enthalpy values for combustion gas using the temperatures measured for each monitoring period.[1]

Since no gas meter was available for direct measurement, the fuel gas usage rate was also calculated. This was accomplished by using the average value from the estimated fuel energy usage (J/hr) and the heating values of the natural gas and propane fuels (J/Nm^3). The corresponding combustion air flowrate was calculated using the 9:1 air-to-fuel ratio provided by plant personnel.

Table 5-2 shows the estimated fuel gas energy usage for the four monitoring periods during which the temperature was varied. Increasing the temperature rise across the burner (burner ΔT) also increased the estimated fuel usage. Estimated energy usage during the overall testing period ranged from 2.26×10^8 J/hr (2.14×10^5 Btu/hr) to 3.53×10^8 J/hr (3.35×10^5 Btu/hr).

During the testing period at Plant C-5, operation with two different catalyst ages was evaluated. The first catalyst was already installed and operating in the incinerator when the testing began. This catalyst was replaced early in the test period because the initial incinerator performance was below expectations. The first catalyst was tested between 18:00 on February 15 and 10:30 on February 16 and was of unknown age. In addition, the catalyst may have been partially deactivated by inadvertent operation above 593°C (1100°F) for a period exceeding several days.

When the incinerator was entered to replace the first catalyst, plant personnel found that no asbestos gasket had been installed at the point where the two catalyst modules join. It is likely that a portion of the SLA was bypassing the catalyst bed, thereby reducing the incinerator performance.

TABLE 5-2. ESTIMATED FUEL GAS ENERGY USAGE FOR MONITORING AT DIFFERENT TEMPERATURES - PLANT C-5

Date	Monitoring Period	Temperature Incinerator Inlet °C (°F)	Temperature Catalyst Inlet °C (°F)	Temperature Rise Across Burner °C (°F)	Estimated Fuel[a] Gas Energy Usage J/hr x 10^8 (Btu/hr x 10^5)
2/16 - 2/17/83	19:31 - 11:23	232 (450)	393 (740)	143 (290)	2.26 (2.14)
2/18 - 2/19/83	22:13 - 00:09	227 (440)	402 (755)	157 (315)	2.42 (2.29)
2/18/83	12:44 - 21:15	235 (455)	468 (875)	216 (420)	3.25 (3.08)
2/17 - 2/18/83	18:08 - 08:40	241 (465)	493 (920)	235 (455)	3.53 (3.35)

[a]Estimated from change in gas enthalpy from incinerator inlet temperature to catalyst bed inlet temperature.

The catalyst installed in the incinerator on February 16 had been rejuvenated by the catalyst manufacturer and remained in the incinerator for the rest of the testing period.

5.2 VOC SAMPLING RESULTS

Method 25A and Method 18 data were collected at Plant C-5 from 2/15/83 to 2/19/83. The data represent four different operating temperatures and two inlet THC concentrations. Data were also collected during incinerator operation with an old and a rejuvenated catalyst. During the testing period at Plant C-5, over 52 hours of Method 25A data were collected.

Results presented in this section for Method 25A and Method 18 analyses are given in parts per million by volume as carbon (ppmvC). Results are reported as carbon but are quantitated against propane standards. All destruction efficiencies have been calculated using THC mass flowrates for incinerator inlet and outlet gas streams. The THC mass flowrates were calculated using the inlet and outlet gas flowrates presented in Table 5-1. An example calculation of destruction efficiency is given in Appendix E.

This section is divided into four parts. The Method 25A results and the effect of operating parameters on performance are discussed in the first two subsections, 5.2.1 and 5.2.2. The results of methane and carbon monoxide analyses are discussed in Section 5.2.3 and Method 18 and GC/MS results are discussed in Section 5.2.4.

5.2.1 Summary of Method 25A Results

Data from Method 25A or total hydrocarbon (THC) analyses for Plant C-5 are presented and discussed in this section. Complete results from these analyses are summarized in Table 5-3 according to monitoring period. Total monitoring time and pertinent process data for each monitoring interval are also included. Periods of non-steady state operation are noted in the table.

TABLE 5-3. RESULTS OF METHOD 25A THC ANALYSES FOR PLANT C-5

Date	Monitoring Period	Minutes of Data Collected	Inlet THC Concentration ppmv-C	Outlet THC Concentration ppmv-C	Destruction Efficiency (%)	Catalyst Inlet Temperature °C (°F)	Catalyst Outlet Temperature °C (°F)
2/15/83	18:17-20:01	105	8954	1876	77.8[a]	396 (745)	485 (905)
2/15-2/16/83	20:07-03:57	470	8908	2194	73.9	407 (765)	499 (930)
2/16/83	03:58-06:04	127	NA	2452	NA	407 (765)	499 (930)
	06:06-08:03	118	NA	2651	NA	402 (755)	488 (910)
	08:04-10:19	118	8710	2422	70.5	410 (770)	502 (935)
	16:48-19:29	162	8535	1404	82.5[b]	379 (715)	499 (930)
2/16-2/17/83	19:31-09:17	826	8720	1591	80.6	393 (740)	507 (945)
2/17/83	09:24-11:23	120	8299	1666	78.7	399 (750)	513 (955)
	11:28-12:30	63	8616	1716	78.9[a]	457 (855)	554(1030)
2/17-2/18/83	18:08-08:40	841	9021	1529	82.0	493 (920)	577(1070)
2/18/83	08:43-10:17	93	8825	1459	82.5[a]	488 (910)	568(1055)
	12:44-14:46	123	8862	1374	83.5	468 (875)	554(1030)
	17:04-21:15	247	9175	1564	81.1[a]	468 (875)	549(1020)
	21:16-22:12	57	8637	1541	81.1	418 (785)	502 (935)
2/18-2/19/83	22:13-00:09	117	8645	1669	79.5	402 (755)	482 (900)
2/19/83	00:10-00:40	31	8841	1916[c]	77.0	399 (750)	479 (895)
	00:41-02:15	95	4638	1526	65.1[d]	413 (775)	457 (855)
	02:16-05:18	183	5047	1155	75.7[d]	418 (785)	454 (850)
	05:19-08:49	204	8480	1605	79.9[e]	399 (750)	477 (890)

NA = Data not available.

[a]Temperature unsteady during a portion of the monitoring period - typically this was 50-100% of monitoring time.

[b]Data collected during period immediately following catalyst changeout. Catalyst not at steady state.

[c]Outlet concentration increased during this period from 1700-2000 ppm. Suspected cause of increase is process upset just prior to shutdown of ½ of coater.

[d]Only half of wire coater operating during this period.

[e]Process not back to steady state after half of coater was down.

During normal incinerator operation, measured destruction efficiencies varied over a wide range, from 65.1 percent to 83.5 percent. The range in efficiencies results from differing catalyst outlet temperatures and differing inlet THC concentrations. The lowest destruction efficiency was obtained when the inlet THC concentration dropped to 4638 ppmvC and the catalyst outlet temperature was 457°C (855°F). The highest destruction efficiency was measured when the inlet THC concentration was 8862 ppmvC and the catalyst outlet temperature was 544°C (1030°F).

Table 5-3 shows that during normal wire coater operations the average inlet THC concentration was 8862 ppmvC. This corresponds to an average inlet THC mass flowrate of 4.53 kg/hr (9.97 lbs/hr). On 2/19/83 from 00:41 through 05:19 one-half of the coating line was not operating. During this period the inlet THC concentration dropped from the average value of 8862 to 4638 ppmvC. Outlet concentrations during normal wire coater operations ranged from 1155 to 2650 ppmvC giving an average outlet THC mass emission rate of 0.869 kg/hr (1.92 lbs/hr).

5.2.2 Effect of Major Operating Parameters on Performance

Parametric analyses were performed on the THC data presented in Section 5.2.1 to assess the effect of major operating variables on incinerator performance. The parametric analyses are discussed in this section and include the following:

- the effect of operating temperature and catalyst age on destruction efficiency;
- the effect of inlet THC concentration on destruction efficiency; and
- the effect of mass of solvent destroyed on temperature rise across the catalyst bed.

A statistical validation has been performed on the first two parametric analyses listed above to verify that the observed functional relationships are not a result of measurement variability (i.e., random sampling error). The results of the statistical validation and the statistical methods used are discussed in detail in the quality assurance report for this program.[2] Conclusions presented in this section regarding the effect of operating temperature, catalyst age and inlet concentration were found to be valid at a confidence level of 95 percent.

Effect of Operating Temperature and Catalyst Age - The Plant C-5 incinerator typically operates at an incinerator outlet temperature of 510°C (950°F). During the testing period the catalyst outlet temperature was varied from 482°C to 577°C (900°F to 1070°F) to observe the effect of operating temperature on destruction efficiency. Average destruction efficiencies and 95 percent confidence intervals are shown in Table 5-4. All of the data summarized in Table 5-4 was taken from steady-state monitoring periods identified in Table 5-3.

Table 5-4 shows that using the new catalyst there is a general trend of increasing destruction efficiency with increasing catalyst outlet temperature. The efficiency increased from 79.5 percent at 482°C (900°F) to 82.4 percent at 554°C (1030°F). At the highest temperature (577°C, 1070°F), however, there is a slight reduction in destruction efficiency to 82.0 percent. The lower efficiency is due to a relatively high concentration of methane in the outlet gas at the higher temperature, 262 ppmv methane at 577°C (1070°F) compared to 90 ppm at 554°C (1030°F). The relatively high concentration of methane in the outlet gas at the higher temperature is suspected to be a result of less complete fuel gas combustion in the burner. In order to maintain the higher operating temperature more fuel gas must be introduced. It appears that the burner is incapable of burning all of this fuel gas efficiently at an incinerator outlet temperature of 577°C (1070°F) or higher.

TABLE 5-4. EFFECT OF CATALYST AGE AND CATALYST OUTLET TEMPERATURE ON EFFICIENCY AT PLANT C-5

Date	Start Time	Catalyst Outlet Temperature °C (°F)	Average Inlet THC Concentration[a]	Average Outlet THC Concentration[a]	Destruction Efficiency, % (Approximate 95% C.I.)[b]	Catalyst Condition	Outlet CH_4 Concentration[c]
2/18-2/19/83	2213	482 (900)	8645	1669	79.5 (79.4, 79.6)	New[d]	35
2/15-2/16/83	2007[e]	499 (930)	8868	2240	73.2 (73.1, 73.3)	Old	83
2/16-2/17/83	1931	507 (945)	8667	1600	80.4 (80.3, 80.5)	New	37
2/18/83	1244	554 (1030)	9070	1501	82.4 (82.3, 82.5)	New	90[f]
2/17-2/18/83	1808	577 (1070)	9021	1529	82.0 (81.9, 82.1)	New	262

[a] As parts per million by volume-carbon quanitated against propane.

[b] C.I. = confidence interval based on measurement variability (i.e., random error).

$$\text{Destruction Efficiency} = \frac{Min - Mout}{Min} \times 100\% \text{, where}$$

$$M = \text{THC Mass Rate} = \frac{(V) \text{ moles C}}{10^6 \text{ moles gas}} \times \frac{12gC}{\text{mole C}} \times \frac{\text{mole gas}}{0.024 \text{ m}^3 \text{ gas}} \times \frac{(Q) \text{ m}^3 \text{ gas}}{\text{sec}}$$

V = THC concentration (inlet or outlet), ppmv

Q = gas flowrate (inlet or outlet), Nm^3/sec

[c] As parts per million by volume-methane.

[d] The new catalyst was actually another batch that had been rejuvenated.

[e] Second monitoring period began 2/16 at 08:04.

[f] Methane concentration is an approximate value obtained from the Method 18 analyses.

Figure 5-1 compares the destruction efficiency calculated from THC data to the efficiency calculated from non-methane hydrocarbon (NMHC) data for each incinerator temperature. Outlet NMHC concentrations were determined by subtracting measured methane concentrations from THC data. The methane concentrations were measured with the Byron 401 or a gas chromatograph. No methane was detected in the inlet gas. The graph shows that NMHC destruction efficiency increases as the temperature increases over the entire temperature range. However, the THC efficiency falls off at the highest concentration due to the methane contribution to the THC.

The results of Method 25A sampling using an old and a rejuvenated catalyst are also given in Table 5-4. Data for the old catalyst show a destruction efficiency of 73.2 percent. During a comparable testing period using the new catalyst, a destruction efficiency of 80.4 percent was achieved. The lower destruction efficiency measured for the old catalyst is probably due to (1) lower catalyst activity caused by age or high temperature operation, and (2) leakage of SLA past the catalyst bed. Leakage occurred because, as discussed in Section 5.1, the asbestos gasket used to join the catalyst modules together was missing.

Effect of Inlet THC Concentration - The effect of inlet concentration on destruction efficiency is shown in Table 5-5. For an increase in the inlet THC concentration from 4900 to 8600 ppmvC, the destruction efficiency increased from 72.3 to 79.5 percent. A catalyst bed outlet temperature increase was also observed for the higher inlet THC concentration.

The increase in efficiency at the higher inlet THC concentration results from an increase in the overall reaction rate of solvent and oxygen in the gas stream. The limited amount of data from Plant C-5 do not allow determination of whether the reaction rate increase is due solely to temperature increase or if the increased solvent concentration also contributes by aiding the mass transfer of solvent to the catalyst surface.

TABLE 5-5. INLET CONCENTRATION VERSUS DESTRUCTION EFFICIENCY

Date	Start Time	Catalyst Temperatures			Average Inlet THC Concentration	Destruction Efficiency,[a] % (95% C.I.)
		Inlet °C (°F)	Outlet °C (°F)	Temperature Rise °C (°F)		
2/19/83	0041	416 (780)	454 (850)	38.9 (70)	4907	72.3 (69.6, 74.5)
2/18 - 2/19/83	2213	402 (755)	482 (900)	80.6 (145)	8645	79.5 (79.4, 79.6)

[a] C.I. = approximate confidence interval based on measurement data variability (i.e., random sampling error).

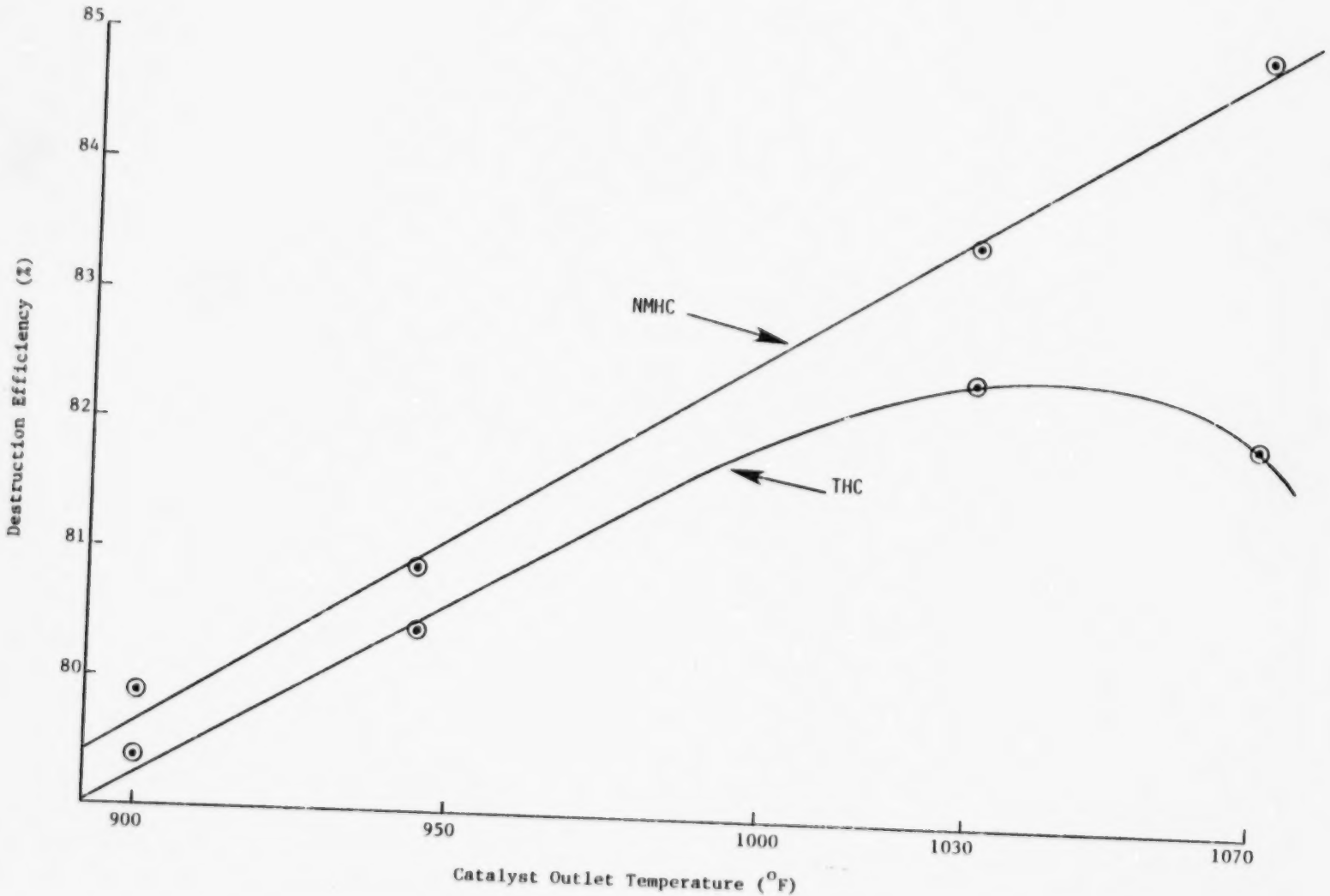

Figure 5-1. Destruction Efficiencies of THC and NMHC

Effect of Mass of Solvent Destroyed - The effect of mass of solvent destroyed in the incinerator on catalyst bed temperature rise is shown in Table 5-6. For most cases, as the mass of solvent destroyed increases, the temperature rise across the catalyst bed (catalyst ΔT) also increases proportionally. When the mass of solvent destroyed increased from 1.81 to 3.51 kg/hr, the catalyst ΔT increased from 38.9°C to 80.6°C.

During the monitoring period in which data was taken at an outlet temperature of 507°C (945°F) the ΔT across the catalyst was approximately 40 percent higher than the ΔT at other temperatures. This testing period was conducted approximately 3 hours after the rejuvenated catalyst was installed and the process was re-started. There is no apparent reason why the ΔT should be different at this temperature than at other temperatures.

5.2.3 Results of Methane and Carbon Monoxide Analyses

Table 5-7 presents the results from monitoring periods where methane and carbon monoxide analyses were performed. Data from 2/16 were collected when the incinerator was operating with the old catalyst in place. Data from 2/16 through 10:00 a.m. on 2/18 were collected when the incinerator was using a 6 percent propane in natural gas fuel mixture; data from 2/18 and 2/19 were collected when the incinerator was burning 100 percent natural gas. The CO and methane data do not show any significant differences as a result of using two different fuels.

As shown in Table 5-7, during monitoring periods for incinerator outlet temperatures of 477°C (890°F) and 513°C (955°F) methane concentrations averaged 36 ppmvC. At 577°C (1070°F) methane was 262 ppmvC. As discussed in Section 5.2.2, the relatively high methane concentration of 262 ppmvC is probably due to a lower fuel combustion efficiency of the incinerator burner at the high temperature. In order to maintain the high operating temperature, more fuel gas must be introduced. It appears that the burner is incapable of burning all of this fuel gas efficiently at an incinerator outlet temperature of 577°C (1070°F).

TABLE 5-6. TEMPERATURE RISE ACROSS CATALYST BED VERSUS MASS OF SOLVENT DESTROYED - PLANT C-5

Date	Time	Catalyst Outlet Temperature °C	(°F)	Inlet Mass Flowrate kg/hr	(lbs/hr)	Mass of Solvent Destroyed kg/hr	(lbs/hr)	Temperature Rise Across Catalyst Bed °C	(°F)
2/19/83	0041	454	(850)	2.51	(5.53)[a]	1.81	(4.00)	38.9	(70)
2/18-2/19/83	2213	482	(900)	4.42	(9.75)	3.51	(7.75)	80.6	(145)
2/16-2/17/83	1931	507	(945)	4.43	(9.77)	3.56	(7.86)	114	(205)
2/18/83	1244	554	(1030)	4.64	(10.2)	3.82	(8.40)	83.3	(150)
2/17-2/18/83	1808	577	(1070)	4.61	(10.2)	3.78	(8.36)	83.3	(150)

[a]Data collected during a monitoring period when only half of the coating line was operating.

TABLE 5-7. RESULTS OF BYRON CO AND CH_4 ANALYSES FOR PLANT C-5

Date	Monitoring Period	Minutes Of Data Collected	Destruction Efficiency	Outlet CO Concentration ppmv	Outlet CH_4 Concentration ppmv	Catalyst Outlet Temperature °C (°F)	Temperature Rise Across Catalyst Bed °C (°F)	Catalyst Condition
2/16/83	08:04 - 10:19	118	70.5	704	83	502 (935)	91.7 (165)	Old
2/17/83	09:24 - 11:23	120	78.7	394	37	513 (955)	114 (205)	New
2/17 - 2/18/83	18:08 - 08:40	841	82.0	634	262	577 (1070)	83.3 (150)	New
2/19/83	05:19 - 08:49	204	79.9[a]	360	35	477 (890)	77.8 (140)	New

[a]Process may not be back to steady state after half of coater was down.

The average concentration of carbon monoxide (CO) at lower incinerator temperatures is 380 ppmv. The CO results from incomplete combustion of methane in the burner and/or solvent in the catalyst bed. At the highest outlet temperature of 577°C (1070°F) the CO concentration increased to 634 ppmv. Like the high methane concentration, the CO levels at this temperature are most likely a result of a lower fuel combustion efficiency in the burner.

Table 5-7 shows that at similar temperatures the outlet methane concentration is 83 ppmvC for the old catalyst and 36 ppmv for the new catalyst. At a given temperature, concentrations of methane entering the catalyst bed from the burner should be about the same. The methane data, therefore, suggest that the newer catalyst destroys methane more efficiently.

Comparison of CO data for the old and new catalyst at similar temperatures show higher CO values for the old catalyst, 704 ppmv compared to 380 ppmv. The higher CO values are probably due to a lower CO destruction efficiency in the catalyst bed and/or less complete combustion of solvent burned in the catalyst bed. The actual destruction efficiencies for methane and CO cannot be calculated because no data are available on the gas composition at the inlet to the catalyst bed (or outlet of the burner).

5.2.4 Results of Method 18 Analyses

Samples of inlet and outlet gas were analyzed by EPA Method 18 (speciation by gas chromatography) to quantitate specific compounds in the gas streams. A summary of these results is presented in Table 5-8. Speciated components are listed in the table according to their retention time from the analyses. The values shown in the table represent average concentrations and standard deviations. Complete results of gas chromatographic analyses are presented in Appendix C.

TABLE 5-8. RESULTS OF HYDROCARBON SPECIATION OF INLET AND OUTLET STREAMS FROM PLANT C-5

Date	No. of Samples	Catalyst Outlet Temperature	Location	Method 18 Concentrations, ppmv[a]													
				C_1-C_5	Benzene	C_6	Xylene		Phenol		o-Cresol	C_7+					
				3.42[1]	3.70	4.25	5.62	5.95	6.52	7.43	8.09	8.52	9.42	10.75	11.39	13.53	THC
2/17/83	3	955	Inlet	21.5± 2.4	41.9± 0.5	10.7± 1.1	83.1± 33.8	52.3± 26.3	10200± 218	158± 4	8.84± 0.11	516± 6	113± 9	294± 8	630± 23	128± 14	12200 ±229
2/18-2/19/83	8	1055 1020 935 890	Inlet	19.0± 1.6	44.5± 9.5	11.3± 4.4	71.8± 3.7	51.2± 9.2	6600± 293	511± 26	160± 18	936± 198	285± 47	393± 78	626± 143	106± 19	9740 ±675
2/17/83	2	1030[b]	Outlet	438± 25	c		5.00± .33	9.07± 1.05	18.0± 8.0	840± 177	19.2[d]	.60[d]	55.6± 25.8	c	8.65± 0.06	25.9± 0.1	17.3± 0.4	1490± 225
2/17/83 2/18/83	7	1055/ 1070	Outlet Outlet	434± 24	c		5.64± 2.84	13.0± 1.7	26.8± 2.2	809± 103	26.5± 9.4	2.84± 4.90	46.0± 9.3	17.8[d]	12.5± 4.9	28.9± 5.9	15.5± 2.5	1530± 138
2/18/83	7	1020/ 1030	Outlet Outlet	84.0± 11.8	75.5± 56.4	7.15±[e] 3.75	11.9± 4.2	19.8± 0.8	1100± 168	19.5± 7.4	1.01± 0.56	51.7± 7.0	20.4± 3.3	11.7± 2.6	26.8± 6.6	18.0± 3.0	1430± 148
2/18-2/19/83	6	900/ 890	Outlet Outlet	57.2± 6.9	26.9± 4.5	8.90± 2.3	32.3±[f] 7.5	23.4± 3.5	1450± 180	32.9± 2.9	1.62± 0.24	89.2± 7.8	20.7± 1.1	42.6± 3.8	72.6± 7.0	20.0± 5.1	1940± 175

NOTE: Numbers above columns represent component retention times.

[a] ppmv = parts per million by volume-carbon, quanitated against propane standards.
[b] Temperatures not at steady state.
[c] Compound merged with the previous compound.
[d] Only 1 value determined. All other peaks were either merged with the previous peak or not integrated.
[e] Average represents the results from 3 of 7 determinations. In the other 4 determinations, this peak was merged with the previous peak.
[f] Values represent the results of poor integration. Actual values are probably about half of the reported values.

Results of speciation indicate that both the inlet and outlet gas streams are comprised primarily of phenol. Phenol represents approximately 70 percent of the THC determined at the inlet. Other components which were identified in the gas streams are cresol and aromatics such as benzene and xylenes. Compounds with molecular weights greater than heptane (C_7) account for 99 percent of the THC. Outlet samples analyzed on 2/17 (1149-1212) and 2/17-2/18 (2025-0907) have a large peak in the C_1-C_5 region. This large peak, which is not seen in the other samples, is most likely a result of the 6 percent propane which was added to the fuel gas during this testing period.

During monitoring on 2/17 the THC inlet concentration was approximately 30 percent higher than inlet concentrations determined on subsequent days. There is no apparent reason for this occurrence. However, one plausible explanation may be that the chromatographic column was not yet fully conditioned for the difficult separation which was required.

Average destruction efficiencies and corresponding 95 percent confidence intervals for benzene, xylene, phenol and o-cresol are shown in Table 5-9 for three different operating temperatures. The data in Table 5-9 for phenol show a fairly large increase in phenol destruction efficiency with increasing catalyst outlet temperature. For an outlet temperature increase from 482 to 577°C (900 to 1070°F), the efficiency increased from 76.7 to 87.0 percent. The increase in phenol destruction efficiency is considered "statistically significant" because the 95 percent confidence intervals do not overlap.

The trend of increasing efficiency with increasing temperature is not quite as well defined for the other three components and for THC. With the exception of benzene, increases in the destruction efficiency are statistically significant from 482 to 554°C (900 to 1030°F). However, the average destruction efficiencies decrease from 554 to 577°C (1030 to 1070°F). These decreases in destruction efficiency are not statistically significant.

TABLE 5-9. DESTRUCTION EFFICIENCIES OF VOC COMPONENTS - PLANT C-5

Date	Catalyst bed Outlet Temperatures °C	(°F)	Destruction Efficiency (Approximate 95% Confidence Interval)[a] Benzene	Xylene	Phenol	o-Cresol	THC
2/18/83-2/19/83	482/477	900/890	16.4 (0, 41.5)	52.3 (44.1, 60.1)	76.7 (74.3, 78.9)	98.9 (98.7, 99.1)	78.9 (76.9, 80.8)
2/18/83	549/554	1020/1030	32.8 (0, 60.2)	82.4 (78.4, 86.2)	82.3 (80.4, 84.2)	99.3 (99.0, 99.6)	84.4 (82.9, 85.8)
2/17/83 - 2/18/83	568/577	1055/1070	47.0 (14.9, 68.1)	80.8 (78.8, 82.7)	87.0 (85.7, 88.2)	98.1 (96.1, 99.9)	83.3 (81.8, 84.7)

[a]Confidence interval based on measurement variability (i.e., random sampling error.)

$$\text{Destruction Efficiency} = \frac{M_{in} - M_{out}}{M_{in}} \times 100\% \text{ , where}$$

$$M = \text{THC Mass Rate} = \frac{(V) \text{ moles C}}{10^6 \text{ moles gas}} \times \frac{12 \text{gC}}{\text{mole C}} \times \frac{\text{mole gas}}{0.024 \text{ m}^3 \text{ gas}} \times \frac{(Q) \text{ m}^3 \text{ gas}}{\text{sec}}$$

V = species concentration (inlet or outlet), ppmv

Q = gas flowrate (inlet or outlet), Nm^3/sec

The data in Table 5-9 show that for the inlet gas stream composition at Plant C-5, the destruction efficiencies of benzene, xylene, phenol and o-cresol increase in the order of increasing molecular weight. However, it should be noted from Table 5-8 that the inlet concentrations of the four components vary fairly widely. This difference in the inlet concentrations could effect the relative destruction efficiencies of the four components and it cannot be concluded that efficiency will increase with increasing solvent molecular weight in all cases.

Two conclusions can be made regarding the relative ease of destruction of three components based on Tables 5-8 and 5-9. First, o-cresol appears to be more easily destroyed than xylene at a catalyst outlet temperature of 482°C (900°F). The inlet concentrations of these two components are similar (72 ppmv and 160 ppmv) and the difference in the destruction efficiencies is fairly large and statistically significant.

Second, o-cresol appears to be more easily destroyed than phenol at all three temperatures. While the inlet concentration of phenol is much higher than o-cresol, which would tend to aid destruction, the observed destruction efficiency of phenol is much lower. This indicates that o-cresol is more easily destroyed.

No conclusions can be made regarding the relative ease of destruction for xylene and phenol or for benzene and any other component. The higher destruction efficiency of phenol compared to xylene could be due to the higher phenol inlet concentration. The lower destruction of benzene compared to the other components may be due to the much lower inlet concentration of benzene compared to the other components.

A comparison of THC destruction efficiencies measured according to Method 25A and Method 18 are shown in Table 5-10. The two test methods are in quite good agreement.

TABLE 5-10. COMPARISON OF METHOD 25A AND METHOD 18 THC DESTRUCTION EFFICIENCIES

Catalyst Bed Temperature Inlet/Outlet °C (°F)	Method 18 THC Destruction Efficiency[a]	Method 25A Destruction Efficiency[b]
402/482 (755/900)	78.9	79.5
468/554 (875/1030)	84.4	82.4
493/577 (920/1070)	83.3	82.0

[a] From Table 5-4.
[b] From Table 5-9.

SECTION 5 REFERENCES

1. Himmelblau, David M. Basic Principles and Calculations in Chemical Engineering Third Edition. Prentice-Hall, Inc. Englewood Cliffs, New Jersey 1974.

APPENDIX A

METHOD 25A SAMPLING DATA

Method 25A sampling data are presented in this appendix. Each section of the appendix contains different data sampling locations as follows:

Section A.1 - Incinerator Inlet
Section A.2 - Incinerator Outlet

Breaks in the data are due to (1) calibration of the Byron or gas chromatograph analyzers, (2) prolonged shutdowns of the manufacturing process, or (3) instrument malfunctions.

The data tabulated in the following sections are expressed in ppmv as carbon (C_1). Data given at one-minute intervals were collected with the Byron 401 in the total hydrocarbon (THC) mode. Data given at two, six, or ten-minute intervals were collected with the gas chromatograph in the THC mode. Data given at twelve-minute intervals were collected with the Byron 401 in the full scan mode.

One format is used in the data listings. The first column gives the time at which the sample was taken for the concentration given in column two of that row. Columns two through eleven contain from one to ten consecutive concentrations beginning at the time given in column one of that row. The time interval between successive concentration values depends on the analyzer and mode used in sampling.

SECTION A.1

INLET CONCENTRATIONS

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=72.08
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/15 18:28

18:28	9956	9404	9165	9074	9019	8961	8887	8940	8954	8945
18:48	8909	8978	8938	9036	8907	8881	8770	8917	8933	8961
19:08	8893	8874	8913	8932	8839	8829				

AVERAGE CONC = 8992. PPM AS C1 FOR 52 MINUTES

19:28	8900	9003	8867	8966	8871	8925	8883	8821	8825	8892
19:48	8885	8783	8812							

AVERAGE CONC = 8879. PPM AS C1 FOR 26 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=72.08
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/15 20:08

20:08	8811	8603	8829	8830	8952	8804	8851	8890	8820	8945
21:08	8873	8855	8872	8835	8911	8830	8898	8950	8830	8900
22:08	8935	8904	8955	8927	8929	8894	8988	8939	8892	8988
23:08	8969	8882	8949	9007	8871	8962	8956	8913	8935	8983
00:08	8967	8864	8990	9021	8929	9005	8915	8924	8932	8962
01:08	8934	8954								

AVERAGE CONC = 8908. PPM AS C1 FOR 312 MINUTES

08:10	8709	8688	8655	8568	8667

AVERAGE CONC = 8657. PPM AS C1 FOR 30 MINUTES

08:40	8661	8694	8711	8784	8705	8737

AVERAGE CONC = 8715. PPM AS C1 FOR 36 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=72.08
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/16 09:20

09:20	8736	8700	8747	8681	8688	8765	8801	8733	8818	8657
10:20	466	129	111	91	90	89	80			

AVERAGE CONC = 5198. PPM AS C1 FOR 102 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.73
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/16 16:50

16:50	8589	8619	8634	8430	8407	8470	8598	8592	8468	8557
17:10	8558	8550	8498	8570	8557	8462	8574	8545	8547	8512

AVERAGE CONC = 8536. PPM AS C1 FOR 40 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.73
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/16 17:50

17:50	8775	8825	8771	8622	8564	8552	8432	8427	8299	8304
19:30	8299									

AVERAGE CONC = 8533. PPM AS C1 FOR 110 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.73
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/16 19:40

19:40	8441	8455	8489	8519	8492	8568	8508	8469	8645	8570
21:20	8670	8657	8701	8719	8704	8725	8699	8822	8745	8812
23:00	8759	8785	8794							

AVERAGE CONC = 8641. PPM AS C1 FOR 230 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.73
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/16 23:36

23:36	8756	8741	8845	8854	8780	8873	8747	8816	8705	8836
01:16	8824	8914	8765	8816	8785	8800	8763	8816	8727	8865
02:56	8659	8763	8648	8767	8704	8849	8781	8951	8786	8886
04:36	8739	8825	8805	8889	8808	8836	8833	8865	8878	8896
06:16	8768	8880	8807	8850	8772	8833	8755	8782	8827	8931
07:56	8669	8660	8548	8564	8302	8366	8308	8276	8268	

AVERAGE CONC = 8751. PPM AS C1 FOR 590 MINUTES

09:26	8343	8220	8367	8088	8318	8250	8378	8326	8371	8277
11:06	8343	8249	8358							

AVERAGE CONC = 8299. PPM AS C1 FOR 130 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.73
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/17 11:36

11:36 8579 8462 8668 8620 8709 8660

AVERAGE CONC = 8616. PPM AS C1 FOR 60 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.4
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/27 17:42

17:42 8598 8668 8972 8927 9111

AVERAGE CONC = 8855. PPM AS C1 FOR 50 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.4
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/17 20:21

20:21 8957 8901 8748 8712 8837 8779 8885 8723

AVERAGE CONC = 8817. PPM AS C1 FOR 80 MINUTES

21:41 8873 8833 9039 9000

AVERAGE CONC = 8936. PPM AS C1 FOR 40 MINUTES

22:21 9075 9058 9048 9063 9031 9060 9026 9171 9073 9185
00:01 9110 9108 9068 9201 9049 9198 9039 9224 9122 9173

AVERAGE CONC = 9106. PPM AS C1 FOR 200 MINUTES

01:41 9131 9227 9212 9173 9129 9198 9179 9195 9182 9102
03:21 9194 9062 9165 9055 9233 9099 9171 9105 9196 9052
05:01 9190 9076 9194 9077 9190 9023 8879

AVERAGE CONC = 9136. PPM AS C1 FOR 270 MINUTES

06:11 8748 8812 8874 8939 8915 8857 8984 8943 8988 8857
07:51 8933 8832 8961 8887 8952 8901

AVERAGE CONC = 8898. PPM AS C1 FOR 160 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.4
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/18 08:51

08:51 8899 8810 8871 8881 8823 8869 8620 8926 8660 8900

AVERAGE CONC = 8825. PPM AS C1 FOR 100 MINUTES

11:22 8818 8917 8875 9000 8810 8966 8958 9007

AVERAGE CONC = 8918. PPM AS C1 FOR 80 MINUTES

12:42 8736 8870 8719 8920 8814 8791 8798 8911 8890 8932
14:22 8883 8972 8869 8976

AVERAGE CONC = 8862. PPM AS C1 FOR 140 MINUTES

15:02 8937 8836 8996 8887 9016 8911 9043 8899 8938 8988
16:42 8879 8988

AVERAGE CONC = 8936. PPM AS C1 FOR 120 MINUTES

17:02 8883 9051 9111 9158 9191 9197 9268 9172 9301 9166
18:42 9294 9284 9321 9261 929? 9334 9216 9353 9259 9416
20:22 9208 9162 8949 8936 989 8885

AVERAGE CONC = 9175. PPM AS C1 FOR 260 MINUTES

21:22 8685 8646 8703 8533 8653 8604

AVERAGE CONC = 8637. PPM AS C1 FOR 60 MINUTES

22:22 8681 8645 8617 8641 8532 8685 8579 8688 8604 8695
00:02 8599 8774

AVERAGE CONC = 8645 PPM AS C1 FOR 120 MINUTES

00:22 8857 8834 4778

AVERAGE CONC = 7496. PPM AS C1 FOR 30 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 RF=76.4
THC CONCENTRATIONS AS C1 IN INLET STARTING AT 02/19 00:52

00:52 4845 4597 4599 4549 4629 4621 4669 4649 4586

AVERAGE CONC = 4638. PPM AS C1 FOR 90 MINUTES

02:22 4585 4587 4629 4560 4596 4603 4666 4637 4597 4597
04:02 4640 4574 4598 4602 4596 4698 4652 8683 8794

AVERAGE CONC = 5047. PPM AS C1 FOR 190 MINUTES

05:32 8653 8537 8441 8474

AVERAGE CONC = 8526. PPM AS C1 FOR 40 MINUTES

06:12 8483 8444 8548 8475 8557 8342 8588 8429 8421 8513
07:52 8442 8470 8430

AVERAGE CONC = 8472. PPM AS C1 FOR 130 MINUTES

08:22 8478 8441 8432

AVERAGE CONC = 8450. PPM AS C1 FOR 30 MINUTES

SECTION A.2

OUTLET CONCENTRATIONS

Reproduced from
best available copy.

DATAVIEW INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=45.01
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/15 18:17

18:17	1299	1444	1444	1570	1570	1660	1751	1733	1751	235
18:27	1859	830	1913	451	1931	1913	1949	1913	2021	2021
18:37	2003	2003	2021	1985	1985	2039	2003	1931	1949	1949
18:47	1985	2021	2021	2076	2021	2021	2039	2076	2021	2076
18:57	2076	2039	2021	2039	2039	2076	2076	2076	2112	2076
19:07	1949	1949	2021	2021	2076	1985	1985	1949	1985	1985
19:17	1985	1913	1931	1913	1931	1949	1949	2039	1841	2003
19:27	1931	2003	1931	1949	1931	1931	1949	2003	1913	2003
19:37	1985	1949	1119	2003	2076	1949	848	1949	1931	2039
19:47	1949	1985	2076	2076	1985	2021	1931	2021	2021	1931
19:57	2021	2021	90	2021	2021					

AVERAGE CONC = 1876. PPM AS C1 FOR 105 MINUTES

20:07	2112	2076	2166	2112	2166	2112	2166	2130	2220	2202
20:17	2130	2166	2112	2202	2202	2220	2130	2130	2166	2166
20:27	2130	2148	2148	2202	2202	2112	2148	2148	2202	2130
20:37	2130	2166	2148	2202	2166	2130	2166	2148	2148	2166
20:47	2166	2148	2130	2166	2202	2166	2238	2112	2220	2202
20:57	2202	2148	2130	2202	2202	2166	2112	2220	2148	2130
21:07	2238	2202	2166	2202	2166	2238	2166	2238	2202	2202
21:17	2148	2166	2130	2238	2202	2130	2238	2202	2202	2166
21:27	2202	2220	2148	2238	2238	2148	2148	2238	2202	2238
21:37	2148	2274	2202	2238	2238	2202	2166	2166	2202	2166
21:47	2166	2166	2238	2238	2202	2202	2238	2202	2202	2202
21:50	2238	2202	2238	2238	2274	2238	2202	2202	2202	2238
22:07	2274	2274	2238	2238	2202	2202	2202	2220	2148	2238
22:17	2238	2202	2238	2292	2292	2238	2238	2238	2238	2274
22:27	2148	2148	2292	2202	2166	2202	2202	2130	2274	2112
22:37	2148	2166	2202	2148	2202	2274	2274	2130	2202	2148
22:47	2166	2112	2238	2130	2148	2238	2148	2076	2076	2021
22:57	2112	2202	2238	2274	2202	2238	2202	2238	2238	2202
23:07	2238	2202	2202	2202	2238	2274	2238	2292	2346	2292
23:17	2202	2292	2364	2130	2238	2238	2238	2238	2238	2076
23:27	2292	2346	2202	2238	2202	2274	2202	2238	2238	2274
23:37	2292	2238	2238	2202	2274	2238	2310	2310	2238	2238
23:47	2364	2292	2292	2238	2310	2238	2274	2292	2274	2346
23:57	2238	2238	2274	2274	2274	2202	2274	2238	2202	2112
00:07	2130	2112	2112	2076	2057	2076	2112	2148	2148	2130
00:17	2148	2076	2112	2112	2076	2076	2166	2130	2076	2130
00:27	2076	2130	2130	2166	2076	2148	2130	2130	2039	2112
00:37	2112	2076	2057	2202	2148	2148	2130	2076	2076	2112
00:47	2130	2076	2166	2148	2112	2202				

AVERAGE CONC = 2189. PPM AS C1 FOR 286 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=46.04
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 00;54

00;54	2112	2166	2166	2112	2238	2130	2130	2148	2166	2112
01;04	2130	2166	2130	2076	2148	2166	2202	2148	2148	2202
01;14	2202	2202	2202	2148	2166	2130	2148	2166	2112	2238
01;24	2274	2130	2076	2202	2202	2238	2148	2112	2148	2166
01;34	2148	2202	2112	2274	2202	2130	2274	2112	2166	2166
01;44	2202	2148	2148	2166	2202	2148	2148	2130	2274	2238
01;54	2238	2238	2130	2238	2202	2076	2202	2166	2202	2238
02;04	2130	2238	2166	2166	2202	2148	2148	2274	2238	2310
02;14	2274	2202	2238	2148	2130	2148	2202	2202	2148	2148
02;24	2166	2238	2202	2202	2202	2148	2238	2148	2238	2166
02;34	2202	2148	2238	2166	2148	2202	2202	2202	2202	2166
02;44	2238	2202	2202	2238	2238	2202	2202	2148	2202	2166
02;54	2148	2292	2202	2238	2202	2202	2148	2202	2238	2238
03;04	2238	2238	2166	2202	2166	2202	2238	2238	2202	2166
03;14	2202	2238	2202	2202	2238	2238	2166	2274	2238	2238
03;24	2238	2238	2274	2202	2346	2274	2274	2202	2274	2274
03;34	2238	2292	2238	2238	2364	2238	2382	2310	2292	2274
03;44	2292	2292	2292	2274	2292	2202	2292	2238	2364	2238
03;54	2310	2238	2238	2202						

AVERAGE CONC = 2202. PPM AS C1 FOR 184 MINUTES

03;58	2382	2437	2328	2491	2346	2527	2473	2527	2437	2527
04;08	2437	2473	2491	2473	2455	2473	2491	2491	2545	2563
04;18	2527	2491	2509	2545	2581	2599	2509	2509	2491	2581
04;28	2563	2545	2527	2509	2563	2563	2545	2545	2599	2545
04;38	2563	2545	2563	2509	2545	2599	2491	2581	2527	2581
04;48	2545	2563	2581	2509	2545	2545	2509	2563	2563	2509
04;58	2509	2581	2563	2617	2617	2617				

AVERAGE CONC = 2525. PPM AS C1 FOR 66 MINUTES

05;04	2130	2599	2599	2527	2310	2310	2382	2382	2346	2382
05;14	2328	2364	2382	2310	2346	2292	2346	2310	2310	2292
05;24	2382	2346	2382	2328	2382	2382	2400	2400	2382	2400
05;34	2310	2382	2364	2382	2346	2346	2400	2346	2346	2382
05;44	2473	2364	2328	2364	2382	2437	2346	2400	2346	2364
05;54	2346	2437	2382	2437	2382	2400	2364	2437	2364	2382
05;04	2328									

AVERAGE CONC = 2372. PPM AS C1 FOR 61 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATIN=5000 MOL.I=46.04
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 06;06

06;06	2400	2437	2400	2400	2346	2364	2346	2455	2328	2382
06;16	2382	2473	2400	2400	2491	2455	2455	2545	2527	2545
06;26	2491	2491	2473	2473	2473	2545	2527	2545	2527	2527
06;36	2581	2491	2527	2563	2527	2599	2617			

AVERAGE CONC = 2473. PPM AS C1, FOR 37 MINUTES

06;43	2743	2743	2725	2725	2743	2725	2707	2725	2725	2725
06;53	2780	2743	2725	2725	2707	2707	2689	2743	2725	2743
07;03	2725	2743	2743	2743	2780	2762	2743	2707	2743	2743
07;13	2743	2743	2707	2743	2689	2725	2816	2743	2725	2725
07;23	2743	2689	2671	2725	2743	2762	2743	2707	2707	2725
07;33	2725	2743	2743	2725	2762	2762	2743	2707	2743	2671
07;43	2780	2707	2743	2725	2707	2689	2762	2743	2743	2743
07;53	2743	2725	2743	2725	2743	2780	2743	2743	2707	2653
08;03	2780									

AVERAGE CONC = 2732. PPM AS C1 FOR 81 MINUTES

08;04	2707	2671	2599	2563	2563	2527	2364	2545	2328	2310
08;14	2346	2238	2346	2346	2292	2238	2328	2346	2328	2455
08;24	2346	2292	2346	2238	2238	2274	2292	2346	2346	2238
08;34	2328	2346	2238	2238						

AVERAGE CONC = 2369 PPM AS C1 FOR 34 MINUTES

08;39	2292	2328	2328	2364	2328	2274	2238	2238	2274	2346
08;49	2238	2292	2328	2292	2382	2292	2328	2400	2364	2364
08;59	2274	2238	2328	2346	2274	2292	2364	2382	2527	2292
09;09	2328	2274	2274	2328	2364	2328				

AVERAGE CONC = 2319. PPM AS C1 FOR 36 MINUTES

Reproduced from best available copy.

CATALYTIC INCINERATOR PROGRAM — PLANT NO 5 — ATIN=2000 MULT=17.93
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 16:48

16:48	837	893	928	985	1047	1062	1104	1104	1118	1104
16:58	1146	1181	1216	1195	1237	1280	1287	1244	1301	1315
17:08	1329	1329	1343	1336	1315	1378	1399	1371	1385	1385
17:18	1385	1399	1399	1406	1399	1441	1427	1399	1406	1434
17:28	1406	1413	1399	1434	1399	1427	1406	1399	1378	1413
17:38	1434	1427	1434	1427	1413	1413	1434	1427	1406	1399
17:48	1434	1448	1441	1413	1441	1441	1427	1441	1469	1448
17:58	1413	1441	1434	1441	1441	1462	1427	1427	1469	1469
18:08	1448	1469	1441	1484	1448	1462	1462	1448	1448	1399
18:18	1441	1434	1469	1462	1434	1448	1462	1476	1462	1441
18:28	1469	1462	1448	1476	1469	1469	1469	1434	1434	1441
18:38	1434									

AVERAGE CONC = 1373. PPM AS C1 FOR 111 MINUTES

CATALYTIC INCINERATOR PROGRAM — PLANT NO 5 — ATIN=5000 MULT=44.84
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 18:39

18:39	1424	1441	1512	1512	1494	1459	1424	1459	1459	1441
18:49	1459	1494	1424	1529	1494	1529	1406	1441	1424	1512
18:59	1512	1441	1441	1529	1529	1459	1512	1459	1459	1494
19:09	1459	1459	1459	1512	1459	1441	1494	1512	1441	1459
19:19	1406	1441	1512	1406	1424	1494	1494	1529	1459	1529
19:29	1529									

AVERAGE CONC = 1472. PPM AS C1 FOR 51 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATIN=5000 MULT=44.84
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 19:31

19:31	1600	1652	1582	1529	1617	1600	1529	1529	1564	1529
19:41	1529	1582	1600	1652	1600	1617	1582	1652	1529	1564
19:51	1652	1600	1582	1582	1617	1652	1617	1670	1652	1600
20:01	1564	1617	1617	1529	1600	1582	1617	1617	1564	1617
20:11	1617	1600	1652	1600	1564	1652	1652	1564	1564	1617
20:21	1582	1564	1600	1617	1582	1582	1564	1600	1617	1582
20:31	1670	1600	1617	1600	1600	1652	1617	1582	1582	1600
20:41	1582	1652	1564	1652	1582	1652	1600	1582	1582	1529
20:51	1600	1617	1600	1529	1617	1582	1582	1617	1652	1564
21:01	1564	1652	1652	1617	1670	1564	1600	1529	1600	1600
21:11	1600	1652	1582	1564	1600	1582	1600	1652	1652	1600
21:21	1529	1617	1652	1600	1564	1529	1529	1564	1564	1529
21:31	1600	1600	1600	1582	1529	1564	1600	1564	1617	1600
21:41	1617	1600	1529	1529	1582	1617	1652	1617	1600	1582
21:51	1582	1652	1617	1529	1600	1529	1564	1529	1564	1600
22:01	1582	1652	1564	1582	1617	1600	1582	1617	1564	1529
22:11	1529	1529	1529	1529	1600	1652	1564	1652	1529	1529
22:21	1529	1582	1600	1582	1582	1529	1617	1617	1564	1617
22:31	1564	1564	1617	1564	1564	1582	1600	1564	1564	1529
22:41	1582	1564	1617	1617	1600	1529	1600	1582	1600	1529
22:51	1617	1652	1582	1564	1582	1600	1600	1582	1564	1652
23:01	1600	1617	1617	1582	1529	1529	1600	1582	1652	1617
23:11	1582	1582	1600	1652	1582	1564	1529	1564	1529	1564
23:21	1600	1600	1582	1529	1529	1652	1529	1635	1652	1529
23:31	1564	1494	1582	1529	1529	1635	1582	1600	1652	1582
23:41	1600	1635	1600	1582	1564	1564	1564	1600	1564	1529
23:51	1564	1600	1582	1529	1600	1652	1529	1617	1600	1529
00:01	1600	1582	1564	1617	1564	1600	1652	1564	1600	1600
00:11	1617	1582	1582	1600	1582	1529	1652	1600	1600	1529
00:21	1529	1564	1617	1582	1582	1564	1529	1582	1529	1564
00:31	1564	1582	1652	1652	1617	1564	1564	1564	1582	1529
00:41	1529	1582	1582	1600	1582	1564	1582	1529	1582	1564
00:51	1564	1600	1582	1564	1600	1582	1564	1529	1617	1617
01:01	1582	1582	1600	1617	1582	1652	1600	1582	1617	1600
01:11	1582	1529	1582	1617	1635	1564	1617	1600	1564	1564
01:21	1582	1529	1652	1652	1617	1600	1600	1564	1600	1582
01:31	1600	1564	1564	1564	1564	1582	1582	1564	1635	1617
01:41	1617	1564	1617	1600	1600	1617	1564	1582	1582	1582
01:51	1582	1652	1564	1564	1617	1652	1529	1564	1564	1564
02:01	1564	1529	1600	1582	1564	1600	1564	1652	1529	1529
02:11	1564	1529	1529	1600	1529	1652	1600	1529	1617	1617
02:21	1652	1564	1600	1600	1529	1617	1617	1617	1600	1582
02:31	1582	1564	1617	1600	1564	1582	1617	1582	1652	1652
02:41	1600	1617	1617	1652	1617	1582	1652	1564	1582	1617
02:51	1652	1617	1652	1600	1617	1617	1617	1582	1652	1652
03:01	1652	1600	1600	1617	1564	1582	1652			

AVERAGE CONC = 1589. PPM AS C1 FOR 457 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.84
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 03:09

03:09	1652	1652	1617	1652	1600	1617	1600	1670	1600	1529
03:19	1564	1652	1617	1582	1582	1564	1617	1564	1582	1582
03:29	1564	1529	1652	1652	1617	1617	1617	1600	1600	1652
03:39	1582	1617	1582	1617	1582	1582	1600	1652	1617	1617
03:49	1582	1687	1600	1617	1582	1582	1529	1582	1582	1582
03:59	1652	1564	1617	1617	1564	1617	1582	1652	1564	1617
04:09	1600	1652	1652	1600	1652	1617	1600	1600	1564	1652
04:19	1600	1652	1600	1617	1652	1617	1600	1652	1564	1652
04:29	1652	1564	1652	1600	1600	1652	1600	1564	1600	1617
04:39	1582	1617	1617	1582	1617	1564	1529	1617	1529	1600
04:49	1529	1617	1617	1582	1529	1582	1582	1652	1617	1652
04:59	1564	1600	1617	1600	1564	1600	1529	1617	1617	1529
05:09	1617	1529	1529	1617	1582	1529	1600	1617	1617	1564
05:19	1617	1582	1582	1564	1617	1564	1600	1600	1652	1600
05:29	1564	1564	1652	1529	1529	1600	1600	1582	1617	1617
05:39	1600	1529	1582	1582	1600	1564	1617	1600	1564	1582
05:49	1600	1652	1617	1652	1617	1582	1600	1600	1564	1582
05:59	1564	1617	1582	1582	1582	1617	1617	1617	1617	1582
06:09	1652	1564	1617	1600	1582	1617	1564	1617	1600	1600
06:19	1564	1600	1617	1617	1670	1600	1652	1600	1582	1617
06:29	1600	1670	1582	1600	1652	1564	1652	1600	1600	1564
06:39	1582	1617	1600	1617	1617	1564	1652	1582	1617	1670
06:49	1652	1670	1564	1670	1652	1652	1652	1582	1652	1600
06:59	1600	1652	1652	1617	1582	1600	1600	1582	1652	1687
07:09	1670	1670	1652	1687	1687	1600	1670	1582	1617	1670
07:19	1670	1687	1582	1670	1670	1582	1652	1687	1687	1617
07:29	1670	1617	1652	1652	1687	1652	1670	1600	1582	1617
07:39	1582	1687	1600	1617	1670	1670	1687	1670	1670	1670
07:49	1687	1670	1670	1687	1670	1652	1600	1582	1529	1582
07:59	1582	1494	1582	1512	1512	1564	1512	1512	1564	1529
08:09	1476	1512	1494	1176	1529	1529	1564	1547	1547	1529
08:19	1476	1512	1512	1564	1494	1564	1494	1529	1564	1582
08:29	1512	1564	1564	1547	1564	1512	1564	1512	1600	1512
08:39	1512	1512	1476	1547	1547	1617	1547	1529	1512	1512
08:49	1564	1529	1512	1512	1600	1582	1564	1582	1547	1600
08:59	1512	1600	1512	1512	1564	1547	1512	1600	1494	1564
09:09	1494	1529	1529	1547	1564	1547	1547	1547	1529	

AVERAGE CONC = 1594. PPM AS C1 FOR 369 MINUTES

11:28	1564	1617	1582	1582	1670	1652	1828	1846	1811	1828
11:38	1828	1811	1934	1881	1846	1811	1775	1705	1758	1811
11:48	1898	1811	1740	1635	1670	1811	1758	1740	1723	1793
11:58	1793	1758	1758	1740	1758	1723	1793	1705	1670	1740
12:08	1705	1740	1793	1723	1705	1670	1723	1652	1705	1652
12:18	1564	1635	1670	1617	1582	1582	1617	1582	1635	1652
12:28	1564	1617	1582							

AVERAGE CONC = 1716. PPM AS C1 FOR 63 MINUTES

Reproduced from best available copy.

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 18;08

18;08	1540	1522	1540	1626	1591	1557	1609	1522	1591	1609
18;18	1540	1557	1540	1557	1591	1522	1557	1522	1626	1505
18;28	1557	1540	1609	1591	1591	1626	1609	1609	1609	1643
18;38	1643	1591	1609	1540	1591	1609	1609	1643	1591	1626
18;48	1591	1557	1557	1557	1591	1591	1505	1557	1522	1626
18;58	1540	1609	1609	1557	1626	1557	1626	1540	1609	1540
19;08	1591	1643	1540	1609	1591	1609	1609	1626	1540	1557
19;18	1626	1626	1643	1609	1661	1626	1540	1643	1591	1609
19;28	1626	1643	1609	1609	1609	1609	1591	1540	1609	1626
19;38	1591	1609	1557	1626	1591	1557	1557	1609	1643	1643
19;48	1643	1626	1643	1557	1626	1591	1557	1557	1557	1661
19;58	1540	1557	1557	1643	1591	1609	1626	1609	1626	1626
20;08	1643	1626	1626	1643						

AVERAGE CONC = 1592. PPM AS C1 FOR 124 MINUTES

21;37	1540	1540	1522	1540	1522	1609	1591	1609	1609	1609
21;47	1540	1522	1540	1522	1626	1540	1609	1557	1470	1609
21;57	1522	1540	1540	1488	1522	1522	1591	1540	1591	1522
22;07	1609	1591	1488	1591	1522	1557	1522	1540	1540	

AVERAGE CONC = 1552. PPM AS C1 FOR 39 MINUTES

22;16	1522	1522	1591	1522	1488	1591	1540	1522	1540	1488
22;26	1522	1557	1557	1522	1557	1609	1540	1557	1540	1557
22;36	1591	1540	1609	1609	1557	1591	1557	1540	1557	1522
22;46	1522	1540	1488	1522	1557	1540	1522	1591	1522	1540
22;56	1540	1557	1540	1522	1540	1609	1522	1540	1522	1540
23;06	1609	1522	1522	1609	1540	1522	1522	1557	1609	1522
23;16	1522	1522	1609	1609	1557	1591	1557	1540	1557	1609
23;26	1557	1557	1488	1540	1540	1557	1540	1488	1522	1522
23;36	1470	1540	1540	1540	1540	1488	1488	1488	1540	1488
23;46	1540	1522	1522	1522	1522	1488	1522	1557	1557	1557
23;56	1488	1522	1557	1522	1488	1488	1522	1522	1522	1557
00;06	1522	1557	1522	1488	1540	1557	1522	1540	1557	1522
00;16	1522	1540	1540	1540	1540	1522	1488	1591	1557	1505
00;26	1540	1540	1522	1557	1557	1609	1557	1591	1557	1591
00;36	1522	1522	1591	1522	1609	1557	1557	1540	1557	1540
00;46	1522	1522	1522	1591	1488	1505	1540	1540	1540	1540
00;56	1540	1540	1557	1522	1522	1522	1505	1522	1522	1488
01;06	1557	1557	1591	1591	1488	1522	1488	1522	1488	1557
01;16	1522	1522	1488	1522	1488	1470	1540	1470	1591	1522
01;26	1540	1522	1522	1522						

AVERAGE CONC = 1538. PPM AS C1 FOR 194 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATIN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 01;30

01;30	1522	1488	1522	1522	1488	1470	1470	1522	1540	1522
01;40	1540	1522	1540	1522	1522	1522	1522	1540	1540	1522
01;50	1522	1488	1488	1557	1488	1540	1557	1540	1557	1488
02;00	1488	1540	1505	1522	1522	1522	1591	1522	1591	1522
02;10	1540	1522	1505	1540	1540	1540	1540	1557	1557	1540
02;20	1505	1470	1540	1591	1522	1557	1488	1488	1522	1557
02;30	1522	1591	1557	1540	1557	1540	1522	1522	1522	1540
02;40	1522	1557	1522	1522	1591	1522	1522	1540	1522	1540
02;50	1557	1522	1540	1591	1522	1557	1522	1557	1522	1522
03;00	1540	1522	1591	1522	1505	1522	1557	1522	1591	1522
03;10	1540	1557	1522	1540	1540	1522	1557	1540	1540	1522
03;20	1522	1540	1522	1522	1522	1522	1540	1540	1557	1557
03;30	1522	1522	1540	1557	1591	1540	1540	1557	1591	1557
03;40	1522	1557	1522	1557	1557	1522	1540	1522	1591	1591
03;50	1591	1591	1557	1522	1522	1505	1488	1557	1522	1522
04;00	1557	1540	1522	1522	1522	1522	1540	1522	1488	1522

AVERAGE CONC = 1534. PPM AS C1 FOR 160 MINUTES

04;11	1522	1557	1557	1522	1557	1522	1540	1522	1505

AVERAGE CONC = 1533. PPM AS C1 FOR 9 MINUTES

04;21	1522	1505	1470	1540	1488	1522	1505	1540	1522	1522
04;31	1557	1488	1540	1522	1488	1540	1522	1540	1522	1522
04;41	1557	1540	1522	1505	1522	1505	1470	1470	1557	1540
04;51	1522	1470	1522	1522	1522	1522	1488	1522	1522	1505
05;01	1522	1488	1505	1522	1470	1522	1522	1488	1522	1540
05;11	1470	1488	1470	1522	1540	1505	1470	1522	1470	1470
05;21	1522	1505	1522	1522	1470	1505	1453	1522	1488	1522
05;31	1522	1488	1540	1453	1488	1488	1522	1488	1522	1505
05;41	1488	1522	1522	1505	1540	1540	1522	1470	1436	1366
05;51	1384	1384	1401	1384	1470	1453	1453	1470	1384	

AVERAGE CONC = 1499. PPM AS C1 FOR 99 MINUTES

08;43	1453	1436	1522	1401	1436	1401	1470	1488	1453	1453
08;53	1453	1366	1470	1366	1401	1470	1488	1453	1436	1436
09;03	1453	1453	1470	1436	1436	1453	1401	1453	1366	1453
09;13	1453	1453	1401	1453	1453	1436	1453	1453	1470	1488
09;23	1488	1436	1436	1436	1436	1436	1453	1470	1453	1470
09;33	1436	1401	1401	1453	1401					

AVERAGE CONC = 1442. PPM AS C1 FOR 55 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 09:39

09:39	1401	1470	1453	1453	1488	1401	1366	1401	1436	1522
09:49	1557	1522	1453	1401	1488	1522	1522	1522	1453	

AVERAGE CONC = 1464. PPM AS C1 FOR 19 MINUTES

09:59	1470	1591	1557	1522	1522	1522	1453	1436	1522	1401
10:09	1522	1453	1522	1557	1453	1488	1522	1557	1470	

AVERAGE CONC = 1502. PPM AS C1 FOR 19 MINUTES

Catalytic Incinerator Program Plant No 5 ATTN=2000 MULT=17.65
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 12:44

12:44	1245	1287	1238	1280	1315	1315	1315	1287	1266	1294
12:54	1315	1328	1315	1342	1335	1301	1328	1328	1342	1328
13:04	1335	1315	1342	1342	1349	1377	1342	1349	1363	1377
13:14	1370	1384	1377	1370	1370	1349	1405	1384	1349	1391
13:24	1418	1384	1391	1377	1363	1370	1349	1370	1384	1391
13:34	1370	1342	1370	1349	1391	1370	1384	1384	1405	1405
13:44	1370	1370	1384	1391	1405	1405	1384	1384	1391	1391
13:54	1398	1370	1349	1370	1384	1418	1370	1398	1384	1425
14:04	1405	1391	1391	1391	1398	1453	1467	1439	1425	1405
14:14	1391	1377	1363	1370	1370	1391	1370	1405	1405	1384
14:24	1377	1425	1439	1432	1425	1425	1432	1439	1405	1398
14:34	1398	1391	1391	1398	1405	1418	1432	1391	1418	1425
14:44	1391	1391	1405							

AVERAGE CONC = 1374. PPM AS C1 FOR 123 MINUTES

17:04	1550	1432	1418	1432	1418	1425	1398	1398	1405	1398
17:14	1432	1439	1439	1439	1439	1474	1495	1508	1536	1550
17:24	1571	1585	1564	1564	1550	1564	1591	1591	1585	1578
17:34	1585	1578	1557	1571	1557	1536	1550	1564	1578	1564
17:44	1578	1591	1598	1578	1571	1585	1585	1550	1591	1585
17:54	1598	1591	1585	1550	1571	1585	1585	1571	1571	1564
18:04	1571	1591	1585	1571	1571	1571	1585	1591	1571	1598
18:14	1564	1571	1585	1591	1598	1619	1591	1585	1571	1598
18:24	1585	1585	1598	1591	1571	1591	1571	1598	1626	1598
18:34	1605	1626	1598	1585	1585	1626	1598	1598	1619	1598
18:44	1619	1605	1598	1619						

AVERAGE CONC = 1558. PPM AS C1 FOR 104 MINUTES

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=2000 MULT=17.65
 THC CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/18 18;49
-------------------------------------------------------------------------------

18;49      1598   1605   1605   1633   1619   1619   1591   1591   1605   1633
18;59      1619   1605   1633   1619   1633   1598

AVERAGE CONC = 1612. PPM AS C1 FOR  16 MINUTES
-------------------------------------------------------------------------------

19;06      1633   1605   1605   1626   1605   1633   1633   1626   1619   1619
19;16      1619   1633   1633   1633   1633   1605   1654   1605   1647   1633
19;26      1633   1626   1619   1626   1633   1647   1633   1654   1668

AVERAGE CONC = 1628. PPM AS C1 FOR  29 MINUTES
-------------------------------------------------------------------------------

19;36      1647   1626   1647   1619   1619   1647   1647   1626   1661   1633
19;46      1661   1633   1619   1633   1647   1647   1633   1633   1647   1654
19;56      1633   1633   1626   1633   1640   1619   1619   1654   1633   1633
20;06      1626   1654   1654   1633   1661   1661   1668   1647   1654   1626
20;16      1647   1626   1647   1654   1654   1633   1626   1633   1626

AVERAGE CONC = 1639. PPM AS C1 FOR  49 MINUTES
-------------------------------------------------------------------------------

CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=5000 MULT=44.13
 THC CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/18 20;26
-------------------------------------------------------------------------------

20;26      1522   1522   1522   1436   1488   1436   1470   1591   1522

AVERAGE CONC = 1501 PPM AS C1 FOR  9 MINUTES
-------------------------------------------------------------------------------

20;36      1453   1401   1436   1401   1436   1522   1470   1384   1401   1436
20;46      1453   1436   1401   1436   1401   1401   1470   1436   1470   1488
20;56      1453   1436   1436   1366   1453   1470   1366   1436   1488   1401
21;06      1470   1453   1436   1470   1401   1470   1436   1470   1453   1453

AVERAGE CONC = 1438. PPM AS C1 FOR  40 MINUTES
-------------------------------------------------------------------------------

21;16      1470   1436   1453   1470   1488   1470   1522   1436   1436   1522
21;26      1470   1522   1470   1522   1488   1488   1522   1488   1522   1540
21;36      1488   1557   1557   1557   1522   1540   1522   1522   1557   1522
21;46      1522   1540   1488   1522   1522   1591   1540   1522   1522   1591
21;56      1522   1522   1626   1591   1557   1540   1591   1540   1643   1609
22;06      1678   1695   1643   1713   1609   1643   1678

AVERAGE CONC = 1541. PPM AS C1 FOR  57 MINUTES
-------------------------------------------------------------------------------
```

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 22;13

22;13	1695	1713	1643	1643	1713	1713	1695	1643	1713	1643
22;23	1643	1609	1643	1678	1678	1626	1609	1678	1643	1695
22;33	1626	1695	1678	1609	1626	1678	1695	1678	1626	1678
22;43	1643	1713	1643	1713	1764	1695	1678	1695	1730	1695
22;53	1713	1678	1643	1678	1678	1678	1678	1713	1609	1643
23;03	1695	1626	1626	1626	1713	1643	1678	1713	1626	1713
23;13	1695	1609	1713	1643	1643	1678	1678	1782	1643	1678
23;23	1643	1695	1713	1713	1695	1609	1626	1678	1626	1695
23;33	1678	1695	1713	1678	1713	1626	1609	1678	1713	1678
23;43	1626	1695	1643	1678	1713	1678	1626	1643	1730	1609
23;53	1626	1626	1626	1626	1626	1609	1678	1626	1695	1678
00;03	1678	1764	1643	1678	1643	1643	1764			

AVERAGE CONC = 1669. PPM AS C1 FOR 117 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/19 00;10

00;10	1764	1730	1764	1799	1851	1868	1834	1834	1955	1955
00;20	1938	2007	1886	1938	1955	1938	2007	1955	1920	1972
00;30	1955	2007	1920	1938	1955	1920	2007	1938	1972	1955
00;40	1989									

AVERAGE CONC = 1916. PPM AS C1 FOR 31 MINUTES

00;41	1920	1938	1938	1920	1955	1989	1938	1972	1972	1920
00;51	1955	1920	1816	1834	1886	1972	2007	1834	1920	1834
01;01	1868	1955	1886	1851	1886	1799	1730	1764	1782	1730
01;11	1713	1626	1695	1643	1591	1626	1591	1522	1522	1591
01;21	1557	1522	1522	1488	1453	1384	1384	1401	1366	1384
01;31	1401	1436	1394	1332	1366	1401	1366	1401	1332	1297
01;41	1297	1366	1263	1245	1332	1366	1263	1366	1280	1263
01;51	1263	1211	1280	1297	1245	1245	1297	1245	1280	1263
02;01	1211	1263	1211	1245	1211	1211	1211	1263	1245	1263
02;11	1211	1176	1176	1211	1211					

AVERAGE CONC = 1526. PPM AS C1 FOR 95 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/19 02;16

02;16	1142	1142	1142	1211	1211	1142	1176	1176	1142	1211
02;26	1176	1142	1176	1176	1211	1211	1211	1176	1142	1142
02;36	1176	1211	1176	1176	1142	1211	1176	1176	1142	1142
02;46	1211	1176	1211	1211	1124	1176	1176	1211	1124	1176
02;56	1176	1090	1142	1142	1211	1142	1124	1176	1142	1176
03;06	1107	1142	1176	1176	1176	1176	1142	1176	1211	1211
03;16	1176	1124	1090	1176	1176	1211	1142	1211	1124	1211
03;26	1142	1176	1142	1211	1176	1211	1124	1124	1176	1124
03;36	1124	1176	1124	1142	1090	1090	1142	1211	1176	1124
03;46	1142	1072	1090	1072	1176	1090	1124	1090	1211	1176
03;56	1055	1211	1090	1176	1090	1090	1107	1090	1159	1176
04;06	1124	1055	1142	1176	1124	1159	1211	1142	1090	1176
04;16	1176	1124	1107	1090	1090	1090	1176	1159	1211	1142
04;26	1176	1124	1176	1090	1176	1176	1142	1124	1124	1090
04;36	1176	1211	1176	1142	1176	1176	1159	1176	1211	1176
04;46	1072	1176	1090	1176	1176	1176	1090	1159	1159	1176
04;56	1211	1159	1124	1176	1176	1176	1211	1159	1124	1159
05;06	1142	1142	1176	1211	1142	1159	1142	1159	1176	1142
05;16	1090	1176	1211							

AVERAGE CONC = 1155. PPM AS C1 FOR 183 MINUTES

05;19	1211	1366	1297	1366	1366	1366	1436	1280	1297	1228
05;29	1366	1315	1297	1401	1315	1384	1453	1470	1401	1470
05;39	1470	1488	1401	1401	1401	1453	1366	1384	1315	1436
05;49	1384	1315	1384	1297	1332	1436	1366	1366	1366	1366
05;59	1366	1384	1366	1366	1384					

AVERAGE CONC = 1370. PPM AS C1 FOR 45 MINUTES

08;11	1764	1782	1713	1730	1764	1713	1782	1730	1695	1764
08;21	1782	1713	1678	1782	1782	1764	1799	1730	1764	1764
08;31	1713	1764	1799	1730	1730	1816	1851	1782	1799	1799
08;41	1868	1868	1816	1851	1816	1782	1868	1851	1868	

AVERAGE CONC = 1778. PPM AS C1 FOR 39 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=46.04
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 09:43

09:43 2473 2545 2527 2599

AVERAGE CONC = 2536 PPM AS C1 FOR 48 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.84
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 09:35

09:35 1687 1652 1670 1617 1670 1670 1652 1652 1687 1705

AVERAGE CONC = 1666. PPM AS C1 FOR 120 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 20:44

20:44 1522 1557 1470 1470 1557

AVERAGE CONC = 1515. PPM AS C1 FOR 60 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 06:16

06:16 1453 1522 1453 1522 1488 1488 1488 1522 1488 1453
08:16 1418 1436 1522

AVERAGE CONC = 1481 PPM AS C1 FOR 156 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=5000 MULT=44.13
THC CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/19 06:18

06:18 1488 1557 1522 1609 1626 1678 1695 1678 1782 1730

AVERAGE CONC = 1636. PPM AS C1 FOR 120 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=25000 MULT=238.5
CO2 CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 09;43

09;43 15620 15059 15246 15246

AVERAGE CONC = 15292 PPM AS C1 FOR 48 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=25000 MULT=241.5
CO2 CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 09;35

09;35 16006 15721 15627 15816 15911 16006 15911 16384 15816 15721

AVERAGE CONC = 15891 PPM AS C1 FOR 120 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=25000 MULT=254.7
CO2 CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 20;44

20;44 19381 20080 20280 19980 20080

AVERAGE CONC = 19960 PPM AS C1 FOR 50 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=25000 MULT=254.7
CO2 CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 06;16

06;16 20380 19980 19680 19780 19381 20779 20580 19382 20380 19581
08;16 19380 20080 19780

AVERAGE CONC = 19895 PPM AS C1 FOR 156 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=25000 MULT=254.7
CO2 CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/19 06;18

06;18 15385 14885 15285 15385 15285 15584 14785 15484 11388 14585

AVERAGE CONC = 14805 PPM AS C1 FOR 120 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=1000 MULT=11.38
CO CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/16 09;43

09;43 750 687 714 665

AVERAGE CONC = 703.8 PPM AS C1 FOR 48 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=1000 MULT=11.60
CO CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 09;35

09;35 382 419 350 373 423 364 396 378 446 410

AVERAGE CONC = 394.0 PPM AS C1 FOR 120 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=1000 MULT=11.95
CO CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/17 20;44

20;44 609 637 623 637 623

AVERAGE CONC = 626.1 PPM AS C1 FOR 60 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=1000 MULT=11.95
CO CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/18 06;16

06;16 675 647 614 628 633 656 680 609 609 505
08;16 666 652 614

AVERAGE CONC = 637.4 PPM AS C1 FOR 156 MINUTES

CATALYTIC INCINERATOR PROGRAM PLANT NO 5 ATTN=1000 MULT=11.95
CO CONCENTRATIONS AS C1 IN OUTLET (LINE 433) STARTING AT 02/19 06;18

06;18 356 375 361 333 384 352 352 356 389 342

AVERAGE CONC = 359.9 PPM AS C1 FOR 120 MINUTES

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=100 MULT=.9398
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/16 09;43
-------------------------------------------------------------------------

09;43        68     83     71   1.11

AVERAGE CONC = 55.73 PPM AS C1 FOR  48 MINUTES
-------------------------------------------------------------------------


CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=100 MULT=.9398
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/17 09;35
-------------------------------------------------------------------------

09;35        41     39     39     38     35     37     34     33     36     38

AVERAGE CONC = 36.81 PPM AS C1 FOR  120 MINUTES
-------------------------------------------------------------------------


CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=500 MULT=4.699
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/17 20;44
-------------------------------------------------------------------------

20;44       260    267    260    256    262

AVERAGE CONC = 260.8 PPM AS C1 FOR  60 MINUTES
-------------------------------------------------------------------------


CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=500 MULT=4.699
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/18 06;16
-------------------------------------------------------------------------

06;16       263    262    263    265    254    267    275    232    276    262
08;16       269    269    262

AVERAGE CONC = 263.0 PPM AS C1 FOR  156 MINUTES
-------------------------------------------------------------------------


CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=100 MULT=.9398
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (LINE 433)  STARTING AT 02/19 06;18
-------------------------------------------------------------------------

06;18        31     32     32     37     31     36     35     37     39     38

AVERAGE CONC = 34.63 PPM AS C1 FOR  120 MINUTES
-------------------------------------------------------------------------
```

APPENDIX B

STACK GAS MOISTURE CONTENT, VOLUMETRIC FLOWRATE AND MOLECULAR WEIGHT DETERMINATION

The results of volumetric flowrate and moisture content measurements performed on the incinerator outlet at Plant C-5 are summarized in Tables B-1 and B-2, respectively. Results shown in the tables were measured according to EPA Methods 1, 2, and 4.

The wet molecular weight of the outlet gas during the testing period averaged 29.0 g/mole. Molecular weight was calculated from the results of fixed gas analysis. Fixed gas analysis of the outlet gas showed 21 percent oxygen, 1.73 percent carbon dioxide and 77.3 percent nitrogen.

TABLE B-1. SUMMARY OF EPA METHOD 2 TEST RESULTS - PLANT C-5

Run #	Date	Start Time	Volumetric Gas Flowrate dNm^3/s (dscfm)	Average Stack Gas Temperature °C (°F)
00	2/15/83	1900	0.287 (608)	464 (868)
01	2/16/83	0846	0.293 (622)	479 (895)
02	2/16/83	1840	0.287 (609)	483 (902)
03	2/17/83	0812	0.292 (620)	492 (917)
04	2/17/83	2040	0.289 (612)	557 (1034)
05	2/18/83	0900	0.273 (579)	531 (988)
06	2/18/83	2052	0.281 (596)	521 (969)
07	2/19/83	0812	0.296 (628)	457 (854)

TABLE B-2. SUMMARY OF EPA METHOD 4 TEST RESULTS - PLANT C-5

Run #	Date	Start Time	Stack Gas Moisture Content %
00	2/17/83	1010	4.96
01	2/18/83	0708	4.89
02	2/18/83	1420	5.27

APPENDIX C

RESULTS OF GAS CHROMATOGRAPHIC ANALYSES

The results of gas chromatographic analyses of gas samples from the incinerator inlet and catalyst outlet are presented in Tables C-1 and C-2, respectively. Compounds are listed according to retention time and identifications have been made where possible. Identifications were made based on retention time comparisons to known standards.

TABLE C-1. RESULTS OF GAS CHROMATOGRAPHIC ANALYSES OF INLET SAMPLES FROM PLANT C-5.

Date	Time	Catalyst Outlet Temperature °C (°F)	Method 18 Concentrations, ppmv[a]													
			C_1 - C_5		Benzene	Xylene		Phenol		o-Cresol						
			3.42	3.70	C_6 4.25	5.62	5.95	6.52	7.43	8.09	C_7+ 8.52	9.42	10.75	11.39	13.53	THC
2/17/83	09:54	513 (955)	21.0	41.3	9.66	60.7	32.6	10231	155	8.81	514	121	285	650	142	12272
	10:29	513 (955)	19.4	42.3	11.8	66.7	42.2	9904	157	8.73	523	115	301	635	128	11954
	11:00	513 (955)	24.1	42.0	10.7	122[c]	82.2	10318	162	8.96	511	104	295	604	115	12399
2/18/83	09:32	568(1055)	17.8	45.5	8.69	72.3	50.5	7039	510	156	932	276	422	728	124	10382
	09:56	568(1055)	19.0	42.9	9.90	71.0	49.4	7082	542	b	1213	319	452	789	132	10721
	20:43	549(1020)	22.0	39.3	10.1	74.5	46.4	6306	504	164	1275	65.8	251	419	83.8	9261
	21:06	549(1020)	18.2	45.9	21.9	147[c]	70.3	6611	542	189	880	362	499	791	343[c]	10520
	21:24	502 (935)	18	66.6	10	70.8	46.4	6425	492	156	790	252	369	561	103	9425
	22:00	502 (935)	20.7	40.5	10.3	78.3	59.0	6502	533	174	852	307	447	102[c]	ND[d]	9126
2/19/83	08:37	477 (890)	18.1	37.4	8.27	67.7	44.7	6470	492	149	785	249	361	563	97.8	9335
	08:56	477 (890)	17.8	37.5	11.6	68.0	42.5	6410	471	133	764	228	345	535	92.7	9156

NOTE: Numbers above columns represent component retention times.

[a] ppmv = parts per million by volume-carbon, quanitated against propane standards.
[b] Compound merged with following compound.
[c] Poor integration values are probably not representative of actual concentrations.
[d] Not detected.

TABLE C-2. RESULTS OF GAS CHROMATOGRAPHIC ANALYSES OF OUTLET SAMPLES FROM PLANT C-5.

Date	Time	Catalyst Outlet Temperature °C (°F)	Method 18 Concentrations, ppmv[a]													
			C_1 - C_3		Benzene	Xylene		Phenol		o-Cresol						
			3.42	3.70	4.25	5.62	5.95	6.52	7.43	8.09	8.52	9.42	10.75	11.39	13.53	THC
2/17/83	11:49	554 (1030)	420	c	4.77	8.33	12.3	714	79.6	ND	37.3	ND	8.6	26	17 1328	
	12:12	554 (1030)	455	c	5.23	9.81	23.6	965	19.2	0.60	73.8	c	8.69	25.8	17.6	1646
	20:25	577 (1070)	408	c	4.78	b	23.9	705	20.2	ND	37.8	NI	6.9	20.7	17.2	1244
	20:47	577 (1070)	449	c	132*	b	85.1	780	22.7	ND	40.3	NI	17.2	31.0	10.3	1568
	21:03	577 (1070)	396	c	3.45	12.2	27.7	938	43.2	11.6	58.6[b]	NI	8.35	26.1	17.4	1538
	21:18	577 (1070)	461	c	27.2*	12.6	26.5	710	101	21.4*	151[b]	c	17.1	31.4	16.0	1576
	21:35	577 (1070)	448	c	4.26	12.7	26.8	724	99.3	20.4*	149[b]	c	16.5	31.5	15.2	1548
2/18/83	08:46	568 (1055)	444	c	5.1	11.4	25.6	888	22.3	0.64	47.4	17.8	8.77	23.3	17.2	1513
	09:07	568 (1055)	431	c	10.6	15.9	30.5	919	24.1	0.67	165[b]	c	45.6	38.2	15.5	1697
	13:44	554 (1030)	88.4	183	c	15.4	ND	1016	7.96	ND	42.9	26.6	7.91	15.3	16.2	1424
	14:11	554 (1030)	85.7	82.6	c	6.74	ND	1096	11.6	2.0	42.7	22.1	8.99	23.7	22.5	1405
	14:33	554 (1030)	92.7	59.7	c	6.27	ND	775	17.9	ND	99.0*	21	12	24	14	1122
	14:58	554 (1030)	61.1	9.0*	2.89	9.63	18.7	1283	23.0	0.81	54.8	20.2	11.9	27.6	17.8	1541
	15:19	554 (1030)	77.2	65.4	c	15.0	20.3	1212	23.8	0.68	56.3	17.1	13.3	35.4	21.5	1558
	16:54	554 (1030)	86.1	32.8	9.97	14.2	20.1	1195	23.9	0.66	58.1	17.2	12.4	30.9	16.7	1519
	20:21	549 (1020)	96.9	29.3	8.58	15.8	20.2	1129	28.3	0.89	55.2	18.3	15.7	31	17	1448
	22:56	482 (900)	51.7	20.3	19.6*	22.4*	18.2	1259	28.0	1.50	75.9	18.8	36.2	66.3	19.9	1630
	23:16	482 (900)	58.8	28.8	28.9*	35.6*	23.5	1550	32.6	1.51	93.0	21.6	44.9	71.4	16.1	2006
	23:35	482 (900)	52.1	31.1	41.8*	41.5*	27.6	1573	34.9	1.62	91.9	21.3	42.2	69.8	14.0	2043
	23:56	482 (900)	51.4	28.0	32.7*	36.6*	26.1	1574	34.4	2.04	95.8	20.6	45.1	84.6	23.2	2027
2/19/83	08:00	477 (890)	60.0	22.4	7.3	24.1*	20.6	1581	34.4	1.43	89.2	21.0	44.7	70.8	26.6	2007
	08:15	477 (890)	68.9	30.6	10.5	33.8*	24.6	1178	168*	80.1*	234*	117*	131*	174*	47.7*	2298*

NOTE: Numbers above columns represent component retention times.

NI = Not integrated. Integrator missed this peak.
ND = Not detected. Detection limit = 1.7 ppmvC.
*Poor integration. Values are probably not representative of actual concentrations.

[a] ppmv = parts per million by volume-carbon, quanitated against propane standards.

[b] Compound merged with following compound.

[c] Compound merged with previous compound.

APPENDIX D

GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS) RESULTS

Appendix D contains the results of GC/MS analyses of extracts of water from the first impinger of the moisture train and of the coating resin used for the base coat. Table D-1 summarizes the major compounds identified, the level of confidence at which they were identified and corresponding concentrations. Table D-2 summarizes only the major compounds identified in the coating sample since the actual coating composition is considered proprietary information.

The GC/MS data is used primarily as a source of qualitative information. The compounds listed in the table all have an identification confidence level associated with them. These confidence levels are defined as follows:

Level 1 - Compound is definitely present. Retention time and mass spectra match known standards.

Level 2 - Compound is probably present. No retention time standard is available but mass spectra match well with library spectra.

Level 3 - This compound represents the best guess for the data available. This could be identified as another compound with the same molecular weight.

The concentrations reported are calculated against a d_{10}-phenanthrene response factor, and are reported as d_{10}-phenanthrene. These concentrations should be viewed only on a semi-quantitative basis since the concentrations presented in Table D-1 reflect the low solubility of phenolic compounds in water. Concentration data from this plant should be used only to compare the relative amounts of one compound to another.

TABLE D-1. RESULTS OF GC/MS ANALYSES OF EXTRACTS OF WATER FROM THE FIRST IMPINGER OF THE MOISTURE TRAIN
(Concentrations are given in ppmv quantitated against d_{10}-Phenanthrene)

Compound	Identification Confidence Level	Concentration (ppmv in gas stream)[a]
Phenol	1	9.46
2-Pyranone	3	0.17
Total cresol	1	3.51
3-Methylbenzaldehyde	2	0.12[b]
Total xylenol	1	3.79
Dimethylbenzaldehyde	2	0.08
Trimethylphenols	1	0.52

[a]Values given represent the average of single determinations of three separate samples.

[b]This compound identified in only one of the samples.

TABLE D-2. RESULTS OF GC/MS ANALYSIS OF THE COATING RESIN - BASE COAT

Compounds Identified
Phenol
Cresols
Xylenols
Trimethylbenzenes
Tetramethylbenzenes
Naphthalene

APPENDIX E

EXAMPLE CALCULATION OF DESTRUCTION EFFICIENCY

Destruction efficiencies for Plant C-5 were calculated from incinerator inlet and outlet THC mass flowrates as follows:

$$DE = \frac{Min - Mout}{Min} \times 100\% = \left[1 - \frac{Mout}{Min}\right] \times 100\% \qquad E\text{-}1$$

where DE = destruction efficiency, %

Min = inlet THC mass rate, g C/sec

Mout = outlet THC mass rate, g C/sec

THC mass rates are based on measured Method 25A concentrations and gas flowrates:

$$M = \frac{(V) \text{ moles C}}{10^6 \text{ moles gas}} \times \frac{12 \text{gC}}{\text{mole C}} \times \frac{\text{mole gas}}{0.024 \text{ m}^3 \text{ gas}} \times \frac{(Q) \text{ m}^3 \text{ gas}}{\text{sec}} \qquad E\text{-}2$$

where M = THC mass rate (inlet or outlet) g C/sec

V = THC concentration (inlet or outlet), ppmv

Q = gas flowrate (inlet or outlet), Nm^3/sec